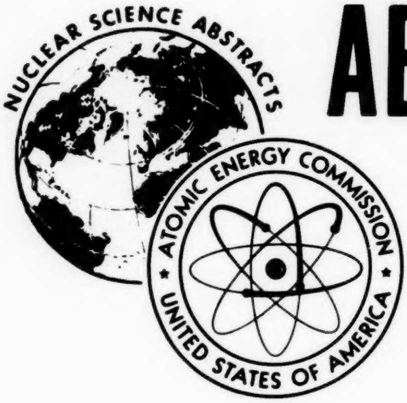
NUCLEAR SCIENCE ABSTRACTS



Volume 25 Number 22

Abstracts 51358-54395

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November 30, 1971

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Volume 25, Number 22, November 30, 1971

NUCLEAR SCIENCE ABSTRACTS

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Published by the USAEC Division of Technical Information Extension, Robert L. Shannon, Extension Manager.

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The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

TRANSURANIUM ELEMENTS
determination in bone ash, radiochemical method for, 25:40 (IDO-12073, pp 28-36)
separation by ion exchange and complex-formation elution, 25:251(P)

TRIETHYLENETETRAMINE
complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137

TRITIUM
content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
determination in luminescent material by scintillation counting, 25:40 (IDO-12073, pp 28-36)

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Use of funds for printing this publication approved by the Director of the Bureau of the Budget, June 26, 1969.

Volume 25, Number 22 November 30, 1971

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 51543, 51584, 51766–51769, 51797, 52291, 52292, and 52363.

Chemical and Spectral Procedures

Refer also to abstracts 51474, 51476, 51620, 51711, 51945, 51989, and 52606.

51358 (AEEW-M-1028) ANALYSIS OF HYDROGEN AND TRITIUM CONTENT OF GRAPHITE AND OTHER MATERIALS. Robinson, B. K. (Atomic Energy Establishment, Winfrith (England)). Apr 1971. 18p. Dep. NTIS (U. S. Sales Only).

Recent work carried out at Winfrith on the analysis of hydrogen in graphite is described. The main purpose was to investigate earlier anomalies particularly with regard to discrepancies in results on comparative samples also analyzed at other establishments. The work was also extended to determine tritium in irradiated graphite and use was made of tritium-containing samples to verify the efficiency of the apparatus. (auth) (UK)

51359 (AERE-R-6537) DETERMINATION OF OXYGEN AND NITROGEN IN SOME NITRIDES AND CARBIDES BY INERT GAS FUSION USING AN IMPULSE HEATING FURNACE. Mead, A. (Atomic Energy Research Establishment, Harwell (England)). Nov 1970. 16p. Dep. NTIS (U. S. Sales Only). UK 2s. 6d.

An inert gas fusion technique, employing an impulse heating furnace at temperatures of 2600 to 2700°C, and a gas-solid chromatographic method of gas measurement are described for the simultaneous determination of oxygen and nitrogen in the nitrides of silicon, titanium, and zirconium and the carbides of titanium and tungsten. A single determination of oxygen and nitrogen requires approximately 10 minutes. (auth)

51360 (CEA-CONF-1783) ELECTRON MICROPROBE ANALYSIS OF HIGHLY RADIOACTIVE MATERIALS. Bazin, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Conte, Madeleine (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires); Perrot, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Van Craeynest, Annick (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1971. 23p. (In French). (CONF-710618-1). Dep. NTIS (U. S. Sales Only).

From thirteenth Euratom hot laboratory meeting; Juelich, Germany (24 Jun 1971).

The analysis or determination in small volumes of the constituents or impurities in a metallic matrix or radioactive ceramics necessitated the reduction of the thickness of the samples; in this way they could be analyzed without modifying the microanalyzer. The method is fast but has certain limitations. A shielded electron microanalyzer was also developed. Samples with a maximum activity of about 10 Ci at 0.75 MeV were examined, the external radiation being less than 2.5 mRad/h. The elements that can be analyzed have atomic numbers ranging from Z = 5 to Z > 94. Metallographic preparation of the sample followed by an α, β, γ decontamination allows this apparatus to be used under conditions similar to those of a standard microprobe. (France)

51361 (CONF-710428-, Paper 1) ENERGY DISPERSION X-RAY (EDX) ANALYSIS IN THE NONFERROUS MINING INDUSTRY. Langheinrich, Armin P.; Forster, James W.; Linn, Thomas A. Jr. (Kennecott Copper Corp., Salt Lake City, Utah). 16p.

From Conference on innovative applications of radiation; Dallas, Tex. (22 Apr 1971).

In Conference on innovative applications of radiation.

Energy dispersion x-ray equipment in combination with radioisotope sources was used successfully in the analysis of mining and milling samples for copper, iron, molybdenum, lead, zinc, and uranium. Sample types included solid materials, solutions, muds, and slurries. A variety of modular combinations of sources, sample cells, Si(Li) detectors, amplifiers, single- and multichannel analyzers, scalers, rate meters, printers and recorders was utilized to fit particular jobs. Test results and filed applications have demonstrated the value of EDX instrumentation as an analytical tool. Its future wide use in the laboratory, the pilot plant and process plant is to be expected. Energy dispersion x-ray equipment has also been applied to the qualitative and semi-quantitative x-ray diffraction analysis of minerals. (auth)

51362 (GAT-655) SECOND-ORDER REFOCUSING 15-INCH MASS SPECTROMETER FOR ULTRA-PRECISE ISOTOPIC RATIO MEASUREMENTS OF URANIUM HEXAFLUORIDE SAMPLES. Kauffman, G. F.; Lang, J.; Martin, W. E. (Goodyear Atomic Corp., Piketon, Ohio). 15 Jul 1971. Contract AT(33-2)-1. 65p. Dep. NTIS.

The relationships between the precision of isotopic ratio measurements and mass spectrometer resolving power are discussed; and a high resolution mass spectrometer capable of ultra-precise isotope ratio measurements of uranium hexafluoride samples is described. The instrument is a single-focusing, 15-inch radius, 90 degree deflection mass spectrometer. The important design features are the use of normal-circle, second-order refocusing pole boundaries and an analyzer tube geometry that exactly compensates for the effects of the magnet fringing fields. The internal precision of the instrument is such that the limit of error of the ratio of mole ratios of a sample pair is ±0.00014 per determination, at the 95 percent confidence level. Ultra-high precision is obtained because the external sources of random variation have been reduced to an insignificant level. The ratio of mole ratios of a sample pair can be evaluated to ±0.00003 with only 4.5 hours of instrument time, to ±0.00002 with 10 hours of instrument time, or to ±0.00001 with 39 hours of instrument time. (auth)

51363 (ORNL-TM-3455) PROGRAM FOR COMPUTING PARTIAL PRESSURES FROM RESIDUAL GAS ANALYZER DATA. Easton, D. S.; Giles, Carla A.; Merriman, Sandra H.; Clausing, R. E. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 96p. Dep. NTIS.

A computer program for determining the partial pressures of various gases from residual-gas-analyzer data is given. The analysis of the ion currents of 18 m/e spectrometer peaks allows the determination of 12 gases simultaneously. Comparison is made to ion-gage readings along with certain other control information. The output data are presented in both tabular and graphical form. (auth)

51364 (SC-RR-71-337) GAS CHROMATOGRAPHIC ANALYSIS OF GASES FOUND IN POST SHOT TUNNEL SYSTEMS. Brewer, L. W.; Parker, D. R. (Sandia Labs., Albuquerque, N. Mex.). Jun 1971. 24p. Dep. NTIS.

The capability to analyze tunnel environment after underground nuclear tests to determine whether toxic and/or explosive gases are present—and to what degree—permits safe reentry of film and the recovery of experiments with minimum delay. The analysis systems used and results obtained in 17 nuclear tests are described. (auth)

51365 EXPERIENCE ON UNIFYING TECHNIQUES FOR ZIRCONIUM DETERMINATION IN TITANIUM ALLOYS. Tenyakova, L. A.; Naplavkova, N. P. Tekhnol. Legk. Splavov.; No. 3, 61-4(1970). (In Russian).

Unifying techniques for zirconium determination in titanium are described. The results of analyses obtained previously were used for calculating mean square deviation for each method and the magnitude of permissible deviations between two parallel determinations was established. (tr-auth) (INIS)

51366 SEPARATION AND DETERMINATION OF MOLYBDENUM BY ELECTRON PARAMAGNETIC RESONANCE. Guilbault, G. G.; Moyer, E. S. (Louisiana State Univ., New Orleans). Anal. Lett. 3: No. 11, 563-71(Nov 1970).

A procedure is described for the separation and quantitative determination of molybdenum by means of EPR. Molybdenum(VI) was precipitated from a hydrochloric acid solution (1.5 M) with α-benzoinoxime. The precipitate was separated by centrifugation and then the sample was dried in an oven at 105°C. Nitrogen was passed over the sample to complete the drying procedure. The precipitate was dissolved in acetonitrile, which was 0.5 M in lithium perchlorate. Electrochemical reduction of the sample produced the molybdenum(V) species. The concentration of molybdenum(V) was determined directly from the intensity of the first derivative EPR signal. The range of linearity of the analytical curve was 1.00×10^{-2} M to 1.00×10^{-4} M, and a routine accuracy of less than 6% was obtained. (auth)

51367 AUTOMATIC IODINE DETERMINATION IN X-RAY CONTRASTERS. Egli, Robert A.; Weber, Roberto (Cilag-Chemie AG, Schaffhausen, Switzerland). Z. Anal. Chem.; 253: No. 5, 355-7(1971). (In German).

A dehalogenation method with 0.15% sodium tetrahydroborate in 1 N sodium hydroxide and palladium as a catalyst (2 m Pd coated brass reaction tube) makes possible the ionization of the organic bound iodine in 5 min at 85°C. Subsequently the aqueous solution is made acidic with sulfuric acid, the iodide oxidized to iodine with the aid of nitrite and then measured photometrically at 455 nm. (auth)

51368 SPECTROPHOTOMETRIC DETERMINATION OF NIOBIUM WITH SALICYLIC ACID. de Salles Andrade, H. A.; Hainberger, L.; Behmel, K. L. (Pontifica Univ. Catolica, Rio de Janeiro). Z. Anal. Chem.; 253: No. 5, 351-3(1971). (In German).

A method is described consisting of the development of a color produced by a concentrated sulphuric acid solution of niobium with salicylic acid. The final concentration of the salicylic acid is 0.100 g/ml of solution and the measurements are made at 430 nm. The minimum limit of determination is 9 μg Nb/ml. Ti, W, Re, and V interfere and must be previously extracted. Ta does not interfere up to certain limits. Separation processes for interferents, sample handling, as well as the advantages of the method, are discussed. (auth)

51369 MASS-SPECTROGRAPHIC ANALYSIS OF POWDERED THERMAL WATER RESIDUES. Klose, M. (Saechsische Akademie der Wissenschaften zu Leipzig, Freiberg, Ger.). Z. Anal. Chem.; 254: No. 1, 7-15(1971). (In German).

The results of mass-spectrographic analyses (with spark ionization) of the solid constituents of some thermal waters of the DDR and of Czechoslovakia are reported including Sr, I, Cs, Pr, Nd, and La. The comparison with well-known classical wet-analyses shows that numerous additional elements (in the case of Johanisbad (Jánske Lázně) more than 20) could be detected by means of this method. In most cases, these elements are contained in the thermal waters in concentrations of ≤0.1 mg/1. The existing investigations into the sensitivity of the elements are still insufficient to allow quantitative interpretations for all the elements. This, however, does not reduce the applicability of this method with regard to the control of the chemical constituents of thermal waters. (auth)

51370 SOME APPLICATIONS OF THE RADIOLYSIS OF WATER IN ANALYTICAL CHEMISTRY. Hunter, William Douglas. Athens, Ohio; Ohio Univ. (1970). 114p. University Microfilms Order No. 71-14,498.

Thesis.

Gamma radiation is used for the titration of iron(II), cerium(IV), uranium(IV), and chromium(VI). The radiolysis products of water, i.e., hydroxyl radicals, hydrogen peroxide, and either hydrogen atoms or solvated electrons, serve as the titrants. Gamma radiation is used to decompose an organic chloride and, thus, allow subsequent determination of the chloride. Gamma radiation is used to precipitate thorium iodate from homogeneous solution. The titration of iron(II), cerium(IV), uranium(IV), and chromium(VI) was followed potentiometrically using a platinum indicator electrode. Oxygen-saturated chloroethanol solutions were irradiated to effect degradation of the chloroethanol, and the liberated chloride was titrated with silver nitrate. Thorium(IV) iodate was precipitated by irradiation of sodium metaperiodate solutions containing thorium(IV). (Diss. Abstr. Int., B)

51371 RADIOGASCHROMATOGRAPHY. Uchiyama, Mitsuru (Tohoku Univ., Sendai). Radioisotopes (Tokyo); 19: No. 11, 551-63(Nov 1970). (In Japanese).

A review of radio gas chromatography is presented including the detectors, carrier gas, adsorbent, flow velocity of the carrier gas, and amount of sample, and, for the radioactivity measurement, characteristics of G-M counter, proportional counter, ionization chamber, and scintillation counter. In operational procedure of this method, the pre-treatment is generally necessary to change effluent fraction to permanent gas for making the measurement effective. A few examples are also shown in this review. (Japan)

51372 EXTRACTION AND PHOTOMETRIC DETERMINATION OF NIOBIUM IN THE PRESENCE OF TANTALUM, TITANIUM, AND IRON. Gorlach, V. F.; Pyatnitskii, I. V.; Kostyuchenko, L. P. (Kiev State Univ.). Ukr. Khim. Zh.; 36: No. 12, 1260-4(Dec 1970). (In Russian).

A photometric method for the determination of niobium in the presence of tantalum, titanium, and iron was developed, which is based on an extraction of niobium peroxide by dibutyl phosphate from sulfuric acid solutions. The complex has an absorption maximum at 350 nm, while tantalum forms a colorless complex. Possible interference by titanium and iron is obviated by their combination with Trilon B. The error of the determination is 5%. Another method of separation using EDTA is discussed. (tr-auth)

51373 ARSENATO-IODOMETRIC DETERMINATION OF CERIUM(IV) AND ALUMINUM SIMULTANEOUSLY. Mamedov, I. A.; Nabiev, M. N. (Azerbaydzhan Inst. of Petroleum and Chemistry, Baku). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 13: No. 12, 1718-19(1970). (In Russian).

A method was developed for the arsenato-iodometric determination of cerium(IV) and aluminum in combination. The method works for wide limits of concentration and the work may be carried out with sufficient accuracy in 30 to 35 min. (tr-auth)

51374 ATOMIC ABSORPTION AND FLUORESCENCE SPECTROSCOPY WITH A CARBON FILAMENT ATOM RESERVOIR. PART IV. THE DETERMINATION OF GOLD BY ATOMIC FLUORESCENCE AND ATOMIC ABSORPTION SPECTROSCOPY WITH AN UNENCLOSED ATOM RESERVOIR. Aggett, J.; West, T. S. (Imperial Coll. of Science and Tech., London). Anal. Chim. Acta; 55: No. 2, 349-57(Jul 1971).

The atomic absorption and fluorescence characteristics of gold generated in an argon atmosphere by a carbon filament atom reservoir and a high-intensity hollow-cathode lamp are examined. Strong fluorescence signals at 242.8 and 267.5 nm were observed which yielded detection limits of 5×10^{-12} and 4×10^{-12} g (0.001 and 0.0008 ppM), respectively. Much weaker fluorescence was also observed at 302.9 nm. Absorption signals occurred at 242.8 nm with a detection limit of 2×10^{-10} g (0.04 ppM). The fluorescence sensitivity is better than the best previously reported for an argon-separated oxy–hydrogen flame. Condensation reactions occur in the gas phase and lead to abnormal loss of atomic gold when 1000-fold concentrations of elements such as Ce, Cr, Cu, Fe, Mn, Mo, Ni, Pd, and W are present in the gold solution. When, however, the fluorescence signals are measured immediately above the surface of the filament, with restricted field viewing, virtually all these interferences disappear. (auth)

51375 SPECTROPHOTOMETRIC DETERMINATION OF RUTHENIUM WITH ACENAPHTHENEQUINONEMONOXIME. Sindhwani, S. K.; Singh, R. P. (Univ. of Delhi). Anal. Chim. Acta; 55: No. 2, 409-14(Jul 1971).

Acenaphthenequinone monoxime was found to be a selective and sensitive reagent for the spectrophotometric determination of ruthenium in the pH range 4.6 to 6.0. The dark blue complex formed shows maximal absorbance at 550 nm. Beer's law is obeyed in the range 0 to 6.57 ppM of ruthenium, the optimal range for determination being 1.50 to 5.05 ppM. The molar absorptivity is 1.5×10^4 l mol^{-1} cm^{-1}. The complex has the composition 1 : 2 metal : ligand. The method is shown to be selective and moderate amounts of other platinum metals do not interfere. (auth)

51376 DETERMINATION OF TRACE AMOUNTS OF LANTHANUM IN LOW-ALLOY STEELS BY FLAME EMISSION SPECTROPHOTOMETRY. Hofton, M. E.; Hubbard, D. P.; Vernon,

XUM

F. (Sheffield Polytechnic, Eng.). Anal. Chim. Acta; 55: No. 2, 367-72(Jul 1971).

A method is described for the determination of 0.00 to 0.008% of lanthanium in steels by flame emission spectrophotometry. After sample dissolution the bulk of the interfering elements is removed by mercury cathode electrolysis. A hydroxide precipitation of lanthanum with silver as carrier is followed, after dissolution of the precipitate, by extraction as its 2-thenoyltrifluoroacetone complex into isobutyl methyl ketone from aqueous solution buffered at pH 5. The organic phase is sprayed into an air—acetylene flame and the emission intensity measured at 743 nm. A "blank" extraction from aqueous solution of pH 2.5 is used to eliminate slight interferences from iron and nickel remaining after the electrolysis stage. (auth)

51377 FLUORIMETRIC DETERMINATION OF MICRO AMOUNTS OF ZIRCONIUM WITH QUERCETIN ON FILTER PAPER. **Desai, S. R.; Sudhalatha, K. (Bhabha Atomic Research Centre, Trombay, India). Anal. Chim. Acta; 55: No. 2, 395-9 (Jul 1971).**

The fluorescence of the zirconium—quercetin complex on filter paper is used for determination of zirconium. Optimal conditions as regards acidity, reagent, concentration, etc., for maximal fluorescence intensity, and the interference of other ions were studied. The method is applied to the determination of zirconium in rock and monazite samples. The ring-oven technique is used to separate zirconium from interfering elements. (auth)

51378 MULTI-ELEMENT ATOMIC FLUORESCENCE SPECTROSCOPY. PART IV. THE DETERMINATION OF COBALT AND NICKEL IN STEELS BY ATOMIC FLUORESCENCE SPECTROSCOPY IN A SEPARATED AIR-ACETYLENE FLAME WITH A DUEL-ELEMENT ELECTRODE LESS DISCHARGE LAMP. **Norris, J. D.; West, T. S. (Imperial Coll. of Science and Tech., London). Anal. Chim. Acta; 55: No. 2, 359-65(Jul 1971).**

The atomic fluorescence determination of cobalt and nickel in a variety of mild, alloy, high-speed and stainless steels is described. The fluorescence of cobalt and nickel at 240.7 and 232.0 nm, respectively, is excited by a dual-element electrodeless discharge lamp, the construction of which is described. An argon-separated air—acetylene flame is used. The dissolved steel sample is aspirated directly into the flame and the cobalt and nickel are read sequentially from calibration curves prepared from pure cobalt and nickel solutions containing approximately the same concentration of acids. The method is rapid, precise, and accurate. Over 20 other common trace and minor metal constituents of steels do not interfere with the procedure nor does the matrix element (iron). (auth)

51379 ANALYSIS OF IRRADIATED MATERIALS USING A SHIELDED ELECTRON PROBE MICROANALYZER. **Cummings, W. V. (General Electric Co., Pleasanton, Calif.); Rosenbaum, H. S.; Nelson, R. C. Contract AT(04-3)-189. pp 179-87 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).**

From eighteenth conference on remote systems technology: Washington, D. C. (Nov 1970). See CONF-701132.

A shielded electron probe microanalyzer was used to examine a specimen of urania—plutonia fuel irradiated to a burnup of 61,000 MWD/Te in a fast flux (in EBR-II). The fuel was clad with AISI Type 347 stainless steel. The instrument was a prototype; its ability to analyze a full cross section of the irradiated fuel was demonstrated. An interaction zone at the fuel-clad interface was examined and found to contain only variations of the cladding components without evidence of fuel or fission products. Precipitated particles were found to contain Tc, Rh, Ru, and Mo. The relative concentrations of these elements in the particles were found to vary with their radial positions within the fuel cross section. The Pu/U ratio of the matrix was slightly higher at the fuel center than elsewhere. (auth)

51380 DETERMINATION OF ZINC IN URANIUM BY DIFFERENTIAL LINEAR SWEEP OSCILLOGRAPHIC POLAROGRAPHY WITH A PERCHLORATE–FLUORIDE ELECTROLYTE. **Plock, C. E.; Vasquez, J. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Anal. Chim. Acta; 55: No. 1, 278-82 (Jun 1971).**

The use of differential linear sweep oscillographic polarography to determine zinc in the presence of uranium without prior separation is reported. The effects of 32 diverse ions were investigated. The peak current was proportional to the zinc concentration. The relative standard deviation of the peak current quotient for all 40 anodic traces was 3.01%. (M.C.G.)

Radiometric and Radiochemical Procedures

Refer also to abstracts 51547, 51856, 51915, 51934, 52135, and 53447.

51381 (A/CONF.49/P–123) SOME RECENT DEVELOPMENTS IN RADIOISOTOPE TECHNOLOGY IN AUSTRALIA. **Gregory, J. N.; Sowerby, B. D.; Spragg, W. T.; Watt, J. S. (Australian Atomic Energy Commission, Sydney). May 1971. 29p. (CONF-710901-163). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Automatic control of mineral processing plants is facilitated by the on-stream analysis of mineral product slurries. Radioisotope x-ray techniques developed for the determination of elements including nickel, copper, zinc, tin, lead, and bismuth are discussed. Gamma-ray resonance scattering for element analysis is being investigated for bore-hole logging and industrial on-stream analysis. The method is simple and highly selective. Both nickel and copper have been measured under conditions that simulate bore-hole situations at 1% by weight concentration. The absolute measurement of gas flow using krypton-85 and the total sample technique gives an accuracy of mass gas flow measurement of ±0.25 per cent. The method has been used for various pipe diameters and pressures in town gas reticulation systems and in the chemical industry. Good photographs have been prepared from negatives that have received only one per cent of the optimum exposure by making the image radioactive and using autoradiography to produce copies of any desired intensity. The world's first fully commercial irradiator was originally designed for quarantine sterilization of bales of goat hair, but now has a multiple role. In addition to the original function, it is used for service sterilization of pharmaceutical products and the production of plastic impregnated timber for flooring and other applications. Ion exchange resins are manufactured using irradiation polymerization and graft polymerization techniques developed by Imperial Chemical Industries of Australia and New Zealand. Research into irradiation polymerization and graft polymerization by Imperial Chemical Industries of Australia and New Zealand has led to the development of novel ion exchange resins which have found application in catalysis, and a product 'Protapol' which is used for solid phase radio immune assay of protein hormones. (auth)

51382 (A/CONF.49/P–164) APPLICATIONS OF ISOTOPES FOR INDUSTRIAL MEASUREMENTS AND CONTROL. **Tolmie, R. W. (Atomic Energy of Canada Ltd., Ottawa (Ontario)). May 1971. 13p. (CONF-710901-181). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Several systems have been designed to analyze minerals, ores, mill products, and other materials by x-ray emission or neutron activation. Ring isotope sources of 100 to 1,000 millicuries each are used for x-ray analysis, and physically large Sb : Be sources of 2,000 to 20,000 Ci are used to generate neutrons. Portable (for x-ray analysis only), transportable, laboratory and on-line equipment has been developed, based on Si and Ge detectors and programmed pulse-height analyzers. These techniques have been combined with preconcentration methods to obtain very high sensitivities, for example to 50 ppB. for some of the platinum metals. They can also be used for air pollution measurements, with sensitivities of about 0.1 μg/m^3. Similar programmed analyzers with computer-compatible magnetic-tape outputs are used for measuring naturally occurring ^{40}K and the daughter radioisotopes of uranium and thorium to locate uranium ore deposits and to assist in general geological studies. Both geological and pollution studies are also being aided by techniques for measuring isotope ratios. Radioisotopes are being used as tracers in a considerable variety of studies of industrial processes, including the study of continuous casting processes, measurement of residence times and channeling and mixing in kilns and ball or rod mills. Dislocation density can be determined from annihilation peak spreading if a positron source is dispersed in the material. In environmental work, tracers are used to measure groundwater movements, leakage from septic tanks, and evaporation from bodies of water. Radioisotopes are also utilized as sources of power for control and signal systems. Applications include a radioisotope-powered lighthouse, navigation buoys, microwave relays, and radio beacons. The heat produced by the sources also ensures proper operation in frigid climates. ^{60}Co is shown to be technically and economically competitive for these applications. (auth)

51383 (A/CONF.49/P–451) DETERMINATION OF SOME RADIONUCLIDES AT THE LEVEL BELOW APC IN LIQUID WASTES, ENVIRONMENTAL AND BIOLOGICAL SAMPLES. **Ershova, Z. V.; Markov, V. K.; Tsvetaeva, N. E.; Ivanova, L. A.;**

(and others) (State Atomic Energy Committee, USSR). Jun 1971. 39p. (CONF-710901-386). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A method is discussed for the determination of ^{90}Sr (from the ^{90}Y content), ^{144}Ce, and ^{137}Cs in salt-free and salt-containing aqueous solutions. The method combines liquid–liquid extraction with co-precipitation. An organophosphorus compound monoisooctyl methylphosphonate is used as the extractant. The ester forms in the presence of some cations a solid organic phase of mixed organic salts as a floc that may be easily separated from the aqueous solution. In this way the radionuclides to be analyzed may be recovered essentially in full (98 to 100%) from large volumes (1 to 20 liters) of aqueous solutions as a solid organic phase in small volumes (0.5 to 10 grams), the procedure requiring at most 30 minutes. Fairly high concentration factors are attained (by a factor of more than 10^3) with a sufficiently complete and selective recovery. The simplicity and speed of the method makes possible its use for systematic control of effluents from treatment stations, surface and underground waters, atmospheric precipitation, etc., even in the field. The possibility of using the method in the presence of large amounts of impurities is discussed. Analysis conditions for the determination of the content of ^{90}Sr, ^{144}Ce, and ^{137}Cs in seawater, food products, and various biological samples (urine, bone tissue, lung tissue, teeth) are outlined. Strontium-90 may be determined in biological samples even in cases in which its content is lower than the maximum permissible concentration. A method is described for the determination of ^{239}Pu based on liquid–liquid extraction by monoisooctyl methylphosphonate and mixed isoamyl phosphate at a phase volume ratio of at least 100. This method is used for the estimation of the ^{239}Pu content in lung tissue, bone tissue, surface waters, and other environmental objects. (auth)

51384 (A/CONF.49/P-556) PREPARATION, PROPERTIES, AND USES OF RADIOACTIVE KRYPTONATES ^{85}Kr IN CHEMISTRY. Toelgyessy, J.; Varga, S.; Jesenak, V. (Slovak Technical Univ., Bratislava, Czech.). May 1971. 28p. (CONF-710901-242). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A review is presented on theoretical problems of incorporation and release of ^{85}Kr from solid carriers, construction of a device for preparation of radioactive kryptonates by ionic bombardment, and new methods for preparation of radioactive kryptonates (sublimation, microdiffusion, and vacuum deposition techniques). Their uses in chemistry include the determination of HCl, $Cr_2O_7^{2-}$, $V(OH)_4^+$, O_2, and pH using calibration curves or by comparison with standards, the determination of Fe^{3+}, Ni^{2+}, Cd^{2+}, Ca^{2+}, Ba^{2+}, Sr^{2+}, Mg^{2+}, Th^{4+}, I_2, H_2SO_4, HCl, and HNO_3 by titration methods, the study of structural and surface changes and phase transformations (dekryptonation analysis of silicate materials), and the study of chemical resistance of glasses, enamels, glazes, etc. (auth)

51385 (BNWL-CC-2239) FISSION PRODUCT RHODIUM AND PALLADIUM. Roberts, F. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 1 Jul 1969. Contract AT(45-1)-1830. 14p. Dep. NTIS.

Milligram quantities of fission product rhodium separated from spent fuel from Yankee and Hanford reactors were analyzed for the ^{102m}Rh and ^{102}Rh content. At discharge the ^{102m}Rh content was estimated to be 290 μCi/g Rh for the 33,000 MWd/t Yankee sample and 20 μCi/g Rh for the Hanford samples. Samples of palladium separated from the Yankee fuel showed no gamma emission. (auth)

51386 (CONF-710617-15) REACTION GAMMA-RAY INTERFERENCES IN THE PASSIVE ASSAY OF PLUTONIUM. Martin, H. R.; Deal, R. A. (Dow Chemical Co., [Golden, Colo.] Rocky Flats Div.). [nd]. Contract AT(29-1)-1106. 15p. Dep. NTIS.

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

Gamma spectra were obtained from a number of plutonium compounds and materials containing elements with low atomic numbers using a Ge(Li) detector. The gamma rays from alpha reactions on these light nuclei were characterized by energy and production mode. With the exception of fluorine, the reaction gamma rays from light elements in the samples investigated do not cause appreciable interference in passive plutonium gamma analysis. The feasibility of using reaction gamma spectra for analyzing unusual neutron or gamma ray counts in waste materials is demonstrated. (auth)

51387 (JAERI-13754) ESTIMATION OF BURN-UP FROM γ-RAY ENERGY SPECTRUM OF FISSION PRODUCTS. Koyama, Kinji; Tasaka, Kanji; (and others) (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Oct 1969. 74p. NTIS (U. S. Sales Only).

To obtain precise estimates on the burnup of nuclear fuel from the γ spectra of fission products, a series of calculations of the energy spectrum were made as a function of irradiation time and cooling time. The Bateman's equation and its integral form were used repeatedly to get the time-dependent concentration of each fission product nucleus. The basic data on β and γ decay were taken from "Table of Isotopes; 6th-Edition, edited by C. M. Lederer, et al.," and the independent fission yields were calculated by using the assumption of C. A. Anderson. Results of the calculations indicated that peaks adequate to the burnup estimation appear in the fission product γ spectrum after the cooling time longer than the irradiation time, and in general the intensity of each peak is represented by a complicated function of irradiation time. However, in the case of ^{95}Nb, ^{137}Cs, and ^{140}La, the intensity of each γ peak decays exponentially, and is proportional to the irradiation time if the cooling time were fixed appropriately. (auth) (Japan)

51388 (LA-DC-12552) ANALYSIS OF DISTILLATES FOR TRITIUM USING LINEAR REGRESSION. Moss, W. D.; Campbell, E. E.; Eutsler, B. C. (Los Alamos Scientific Lab., N. Mex.). [nd]. 7p. (CONF-710809-4). Dep. NTIS.

From Tritium symposium; Las Vegas, Nev. (30 Aug 1971).

Low levels of tritium may be determined by a simple method that uses the count rate as a function of sample volume. The method involves the preparation and scintillation counting of a series of samples. Samples of a constant ratio of water to cocktail and increasing total volume have the same counting efficiency. A statistical linear regression analysis of the count rate as a function of volume is the basis of determining the tritium concentration. The statistical methodology used and the significance of the method will be shown. (auth)

51389 (SWRHL-500-r) SEPARATION TECHNIQUE FOR THE DETERMINATION OF ^{85}Kr IN THE ENVIRONMENT. Stevenson, D. L.; Johns, F. B. (Western Environmental Research Lab., Las Vegas, Nev.). [1969]. 11p. (CONF-710705-5). Dep. NTIS.

From International symposium on rapid methods for measuring radioactivity in the environment; Munich, Germany (5 Jul 1971).

A carrier-free chromatographic method for separating krypton from an atmospheric sample is described. The krypton is then dissolved and counted in liquid scintillation solution. The method is comparatively simple, reproducible, and sensitive enough to routinely detect environmental levels of ^{85}Kr. (D.H.M.)

51390 TECHNETIUM CALIBRATION: AN INHERENT ERROR USING SCINTILLATION CRYSTALS. Nusynowitz, Martin L.; Waliszewski, Jerome; Goldsmith, William A. (William Beaumont General Hospital, El Paso, Tex.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 715-19(Aug 1971).

Calibration procedures for ^{99m}Tc using a ^{57}Co standard and a sodium iodide crystal scintillation detector have been commonly employed. These assays have utilized a variety of detectors, geometries, and attenuators on the assumption that the relative efficiency between the 2 radionuclides is constant. It was found that the assumption of constant relative efficiencies for all geometries is invalid. It is concluded that assay of ^{99m}Tc should be performed in an ionization chamber or in a crystal detector calibrated for the particular attenuation and geometry selected, using either a calibrated ^{99m}Tc source or an ionization chamber dose calibrator. (auth)

51391 METHODS OF LABORATORY DETERMINATION OF RADIOACTIVE ELEMENTS IN ROCKS. Bozhichko, M. A.; Kuznetsov, A. G.; Smyslov, A. A. Tr. Vses. Nauch.-Issled. Geol. Inst.; 164: 54-76(1968). (In Russian).

A survey, with brief descriptions, of the leading methods of analytical determination of radioisotopes in rocks is presented. A section on the radiochemical determination of Ra and Th is followed by the colorimetric determination of Th, and luminescence methods for U. The remainder of the paper is devoted to radiometric methods for U, Ra, and Th, classified according to the type of radiation emitted: (1) β and γ rays, (2) α rays, and (3) gamma spectrometry using scintillation counters. Radiometric techniques for α emitters (no. (2), above) are further subdivided into determinations of U and Th based on the difference in (a) the energy composition of the α emitters present, (b) the quantity of α particles emitted, and (c) the decay constants of the U and Th series, respectively. 20 references. (K.S.W.)

51392 MEASUREMENT OF THE GAMMA ACTIVITY OF SEAWATER BY AN IMMERSION SCINTILLATION COUNTER. Vinogradov, A. S.; Vinogradova, K. G. Tr. Morsk. Gidrofiz. Inst., Akad. Nauk Ukr. SSR; No. 41, 122-31(1969). (In Russian).

A mathematical relation is developed, which shows that the dimensions of the container, in which a counter is submerged, have no effect on the count rate. A submersible scintillation counter was tested in seawater at a depth of 100 m for its ability to count the gamma rays from ^{40}K. Satisfactory agreement with prediction by other means was obtained. Identification of gamma-active elements in solution and the determination of their activities are complicated by transformation of the original gamma radiation spectra, as the result of interaction with the solvent. Compton scattering gives rise to a complex form of the "equilibrium" spectrum of the gamma radiation, whereas the original was a line spectrum. (K.S.W.)

51393 OXYGEN FLASK COMBUSTION METHOD FOR THE RADIOACTIVE ANALYSIS OF ^{35}S AND ^{75}Se IN BIOLOGICAL SAMPLES. Miller, K. R.; Allsop, T. F. (Dept. of Agriculture, Wellington, N. Z.). N. Z. J. Sci.; 13: 149-59(Mar 1970).

An oxygen flask combustion technique, modified to enable the platinum baskets and supporting electrodes to be washed by the absorbent, is suitable for the radioactive analysis of ^{35}S and ^{75}Se in biological samples. With the weights of samples combusted at 50 to 200 mg the recoveries were better than 95%. (auth) (INIS)

51394 ESTIMATION OF ERROR IN THE DETERMINATION OF ^{26}Al IN STONE METEORITES BY INDIRECT γ-RAY SPECTROMETRY. Rowe, M. V.; Clark, R. S. (Texas A and M Univ., College Station. Radiation Counting Lab., Houston, Tex.). Geochim. Cosmochim. Acta; 35: No. 7, 727-30(Jul 1971).

The error involved in the determination of the ^{26}Al concentration by the method of Rowe 1961 and his co-workers was measured and the values they reported should be increased by a factor of 1.36 ± 0.05. The potassium contents of the meteorites measured by Rowe et al. 1961, 1963, 1964, are not affected by this error and can be used with confidence. (auth) (UK)

51395 QUANTITATIVE DETERMINATION OF AMERICIUM IN URINE. Patti, F.; Bullier, D. (CEA, Fontenay-aux-Roses, France). Radioprotection; 6: No. 2, 149-57(1971). (In French).

A method of analyzing radiotoxicity using resin ion exchange was developed for the specific determination of americium in urine, blood, feces, and tissues. The reproducibility of the results was confirmed by the radiochemical yields. When α-emitting isotopes of Th, Pa, Np, and Pu are found in samples with americium, two resin columns must be used. The quantities of plutonium and americium can be determined under specified conditions; isolation from the elements quoted was studied. The sensitivity of the method is about 0.1 picocurie per liter. (auth) (France)

51396 SIMPLIFIED RADIOCHROMATOGRAPHIC PURITY CHECK. Gutkowski, Robert F.; Dworkin, H. J. (William Beaumont Hospital, Royal Oak, Mich.). J. Nucl. Med.; 12: No. 7, 513-15(Jul 1971).

A device is suggested, which permits rapid and inexpensive radioanalysis of chromatography strips. Radiochromatography is frequently used to assess the purity of kit-made radiopharmaceuticals such as ^{99m}Tc-labeled-sulfur colloid. The device, a radiochromatogram-well-adapter, is easy to construct and is accurate. Results are available before short-lived radioactive drugs are administered to the patient. (auth)

51397 ^{210}Po CONTENT IN DIFFERENT CIGARETTE BLENDS. Furnica, Gh.; Toader, M. (Institutul de Igiena, Bucharest). Igiena (Bucharest); 18: No. 8, 469-74(1969). (In Rumanian).

Recent investigations supplied evidence of the presence of ^{210}Po in tobacco and cigarette smoke, and a higher content in the organisms of smokers. ^{210}Po was isolated radiochemically from various Romanian cigarette blends and the content determined by measuring alpha activity in a methane gas counter. Results showed a variable ^{210}Po content, depending on the blend of the cigarette, and oscillating between 0.04 and 0.29 pCi/g, or 4×10^{-18} to 3×10^{-17} gPo/g tobacco. (auth)

51398 ABSOLUTE DETERMINATION OF ^{148g}Pm BY γ-RAY SPECTROMETRY AND A MEASUREMENT OF THE EMISSION PROBABILITY OF ITS 1.465-MeV γ-RAY. Cabell, M. J.; Wilkins, M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem.; 33: No. 7, 1957-62(Jul 1971).

The activity of aliquots taken from a common stock containing a mixture of ^{147}Pm, ^{148g}Pm, ^{148m}Pm, and ^{149}Pm was determined as a function of time by (a) counting the β^- particles emitted, using a $4\pi\beta$-γ coincidence counter and by (b) counting the 1.465 MeV γ photons emitted, using a γ spectrometer. The gross β^- decay curves were then analyzed by the method of weighted least squares and the absolute disintegration rates of the ^{148g}Pm in the sources were derived. By combining this data with the results of the γ spectrometry, the γ counter was calibrated for determining ^{148g}Pm absolutely with an accuracy of ±0.8%. The probability of a 1.465 MeV γ photon being emitted in the β^- decay of ^{148g}Pm was found to be 0.222 ± 0.005 per disintegration. (auth) (UK)

51399 RADIO-RELEASE TECHNIQUE FOR DETERMINING TRACES OF ELEMENTS. DETERMINATION OF MERCURY. Krivan, V. (Univ., Freiburg i. B.). Z. Anal. Chem.; 253: No. 3, 192-4(1971).

A radio-release technique for the determination of traces of elements is described. A small amount of an insoluble compound is fixed on a small disc of filter paper or other suitable material. The exchangeable ions of this compound are labeled with a radioactive isotope and are then replaced with ions of the trace element to be determined in a solution. After the labeled ions are released from the carrier into the solution by shaking, the activity of the species released is measured and compared with one, or, a series of standards processed in the same way. A radio-release method for the determination of mercury, which is applicable to contents >0.25 μg per ml, in the presence of several other elements including bismuth, lead, thallium, cadmium and copper, is described. The advantages and limitations of this method are discussed. (auth)

51400 APPLICATIONS OF RADIOISOTOPES IN ELECTROCHEMICAL ANALYSIS. Huertes, Vicente Almagro. Energ. Nucl. (Madrid); 7: No. 68, 494-500(Nov-Dec 1970). (In Spanish).

The application of radioisotopes in electroanalysis is based on substituting the measurement of the electrolysis current by the measurement of the radioactivity of an isotope deposited on an electrode under the same conditions as exist in the normal electroanalytical method. In addition to the selectivity of the electroanalytical method high sensitivity is obtained. The application of controlled-potential electrolysis to activation analysis is indicated. The experimental techniques used and some applications such as the simultaneous determination of ^{95}Zr, ^{106}Ru, and ^{95}Nb, are described. (tr-auth)

51401 TRACER METHOD FOR ^{14}C CALIBRATION. Bowes, G. C.; Baerg, A. P. (National Research Council of Canada, Ottawa). Int. J. Appl. Radiat. Isotop.; 22: No. 7, 431-4(Jul 1971).

Efficiency tracing is used as a method of measuring ^{14}C beta activity. The suitability of various carbon sources, their preparation and problems are discussed. Oxalic acid was primarily used. ^{60}Co and ^{134}Cs were found to be more convenient tracer elements than ^{95}Nb, which is normally used. Source preparation and assay are described. The use of a tracer with a complex β decay for checking the validity of the tracer methods is discussed and a method of testing for systematic errors due to biased source unhomogeneities described. Oxalic acid and glucose solutions were tested for stability. The tracer method with nonlinear data fitting appears to be basically valid for absolute calibration of ^{14}C but various limitations are noted. The possibility of use of liquid scintillation counters is suggested. At present compensated gas counters give the most reliable ^{14}C standards. (UK)

51402 TWO METHODS OF DETERMINING PPM QUANTITIES OF ^{236}Pu IN ^{238}Pu. Tomlinson, F. K.; Smith, W. H.; Eppink, D. W.; Hagee, G. R. (Monsanto Research Corp., Miamisburg, Ohio). Nucl. Technol.; 12: No. 3, 314-19(Nov 1971).

Two methods were developed for the determination of plutonium-236 in plutonium-238. One method involves the direct measurement of plutonium-236 in the presence of plutonium-238 dioxide. The second method consists of an indirect radiochemical determination of the ratio of daughter products from plutonium-236 and plutonium-238 (i.e., uranium-232 and uranium-234). Both methods produce similar results although each has its own distinct advantages and disadvantages. (auth)

Activation Procedures

Refer also to abstracts 51963, 52071, and 52073.

51403 (A/CONF.49/P-19) NEUTRON ACTIVATION ANALYSIS USED IN ENVIRONMENTAL POLLUTION PROBLEMS. de Goeij, J. J. M.; Houtman, J. P. W. (Interuniversitair Reactor Instituut, Delft (Netherlands)); Das, H. A. (Reactor Centrum Nederland, Petten). May 1971. 20p. (CONF-710901-69). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

An extensive study of sludge transport was made in which neutron activation was used for the analysis of sludge for polluting elements. Activation analyses for manganese, chromium, copper, lanthanum, cobalt, samarium, and scandium were performed nondestructively. The mercury determination in water, sludge, and a variety of biological samples was carried out destructively. Neutron activation was also used in air pollution studies for the routine analysis of air dust samples. Instrumental determinations were performed after activation with thermal and fast neutrons, and with photons. Twenty elements are determined initially; As, Mo, Cd, I, and Hg are determined after chemical separation following irradiation with thermal neutrons. Fluorine is determined by fast neutron activation, followed by chemical isolation of H_2SiF_6. (J.G.B.)

51404 (A/CONF.49/P–110) DETERMINATION OF TRACE ELEMENTS BY NEUTRON ACTIVATION ANALYSIS. Qureshi, I. H.; Nagi, F. I.; Cheema, M. N.; Nasra (Atomic Energy Centre, Lahore (Pakistan)). Jun 1971. 11p. (CONF-710901–366). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A rapid and simple extractive separation of antimony, arsenic, and copper using tribenzylamine was also developed. The accuracy and reproducibility of this procedure was checked by applying it to a NBS SRM No. 127_a (solder material) for the simultaneous determination of these elements. (auth)

51405 (A/CONF.49/P–464) INDUSTRIAL NUCLEAR METHODS AND EQUIPMENT FOR ELEMENTAL ANALYSIS. Shtan, A. S.; Mamikonyan, S. V.; Ivanov, I. N.; Alimarin, I. P.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 26p. (CONF-710901–390). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Requirements for methods for analysis of the composition of matter are discussed. An estimate of the status of development of nuclear physical methods and apparatus in the Soviet Union is given. Activation and x-ray methods of analysis are discussed in particular. Special radiation sources for activation analysis in the Soviet Union are described. A brief description of three types of automatic systems designed for use with activation analysis is given. They are a system with a specialized calculating device for determining one or two elements, a system with a small computer designed for determining 4 to 6 elements with the help of programs developed in advance, and universal systems provided with a special device connecting the measuring apparatus with a computer center. X-radiometric analysis is used for the determination of a large spectrum of elements (from aluminum to uranium) with a sensitivity equal to 10^{-2} to 10^{-3} of the amount of an element of interest, and with a precision that is not less than that of usual chemical determinations. The duration of the analysis is ten minutes or less. (auth)

51406 (CONF-710617–10) CYCLIC ACTIVATION TECHNIQUE FOR NON-DESTRUCTIVE FUEL ANALYSIS. Jamieson, John M.; Graham III, W. Waverly (Georgia Inst. of Tech., Atlanta. School of Nuclear Engineering). [1970]. 6p.

From 12. annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

A method for analysis of nuclear material by delayed neutron yield after an active activation interrogation is presented. The sample is activated in a cyclic manner and the steady state delayed neutron response is studied as a function of interrogation frequency. (D.H.M.)

51407 (CONF-710623–1) AUTOMATED SEPARATIONS IN ROUTINE ACTIVATION ANALYSIS OF MERCURY. De Goeij, J. J. M. (Interuniversitair Reactor Instituut, Delft (Netherlands)). [1971]. 10p. Dep. NTIS (U. S. Sales Only).

From second conference on the recent developments in neutron activation analysis; Cambridge, England (28 Jun 1971).

A simple, rapid and sensitive analysis for mercury, based on neutron activation analysis and automated chemical separations is described. Mercury levels for Dutch fish, shell fish, and imported canned fish are presented. (auth)

51408 (IFA-NR–34) INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF SOME GERMAN AND CZECHOSLOVAKIAN ROCK STANDARDS. Cojocaru, V.; Ispas, Maria (Institutul de Fizica Atomica, Bucharest (Romania)). [1970]. 13p. Dep. NTIS (U. S. Sales Only).

Using high-resolution Ge(Li) detectors and neutron activation analysis, 24 elements were determined in six standard rocks: GM (granite), KH (limestone), TB (argillite), BM (basalt) and an anhydrite, prepared in the Democratic Republic of Germany, and a magnesite prepared in Czechoslovakia. A comparison between three different graphites (GM, G-1, and G-2) is given. (auth)

51409 (IS-T–458) NEUTRON ACTIVATION ANALYSIS FOR OSMIUM AND RUTHENIUM IN PLATINUM. Payton, Gerald James (Ames Lab., Iowa). Aug 1971. Contract W-7405-eng-82. 141p. Dep. NTIS.

Thesis.

A sensitive, destructive analytical procedure utilizing thermal neutron activation analysis was developed for the simultaneous determination of trace amounts of osmium and ruthenium in both commercial and purified platinum stock. One to two hundred milligram samples of platinum and irradiation standards in submilligram amounts of the elements to be determined were irradiated for periods of up to 260 hours with a thermal flux of ca. 3×10^{13} $n \cdot cm^{-2} \cdot sec^{-1}$. The radiochemical separation scheme involved selective distillation of the volatile tetroxides of osmium and ruthenium which utilized the temperature dependent oxidative power of perchloric acid. The recorded gamma spectra were analyzed by a computer technique. Average impurity contents of 32 ± 7 ppB of osmium in five analyses and 44 ± 5 ppB of ruthenium in six analyses were obtained for the purified platinum stock investigated. The commercial platinum wire yielded an average impurity content of 0.134 ± 0.010 ppM of osmium in seven analyses and 1.04 ± 0.04 ppM of ruthenium in seven analyses. The overall errors in the results appeared to be mostly due to uncertainties inherent in gamma spectrometry and possible inhomogeneities in the platinum samples. The errors due to self-shielding during irradiation, and the interferences arising from secondary neutron reactions and threshold reactions, were deemed insignificant. (auth)

51410 (NYO–3953-3) APPLICATION OF NUCLEAR TECHNOLOGY TO ART IDENTIFICATION PROBLEMS. Third Annual Report, February 1, 1970–February 28, 1971. Keisch, Bernard; Miller, Holly H. (Mellon Inst., Pittsburgh, Pa.). Feb 1971. Contract AT(30-1)-3953. 52p. Dep. NTIS.

The use of neutron activation analysis (NAA) to distinguish between sources of lead white is shown to be effective when: (1) samples are treated to remove extraneous materials; and (2) data are handled on the basis of probable trace element concentration distributions. A similar application of NAA for distinguishing between synthetic material is also presented. Several results demonstrating the practical application of the natural alpha radioactivity lead "dating" technique are presented. The final design and some applications of a small-sample, low-level carbon-14 detector are described. This counter is shown to be useful for discerning between linseed oil of recent (since ca 1960) and older (before ca 1952) origin including that found in paintings. A preliminary exploration of the application of alpha-recoil track dating techniques to materials of art is described. (auth)

51411 RAPID DETERMINATION OF THALLIUM TRACES BY ACTIVATION ANALYSIS APPLYING SUBSTOICHIOMETRIC DISPLACEMENT. Adamek, A.; Obrusnik, I. (Inst. of Physics, Bratislava). Radiochem. Radioanal. Lett.; 7: No. 3, 147-54 (1 Aug 1971).

A method of substoichiometric displacement was used for the separation of ^{206}Tl produced by irradiation with thermal neutrons in aluminium foils at a neutron flux of the order of 10^{16} m^{-2} s^{-1}. After dissolution of the sample, Tl was extracted as thallium (I) dithizonate and then, using a standard Hg^{2+} solution, ^{206}Tl was substoichiometrically displaced from the organic to the aqueous phase. After evaporation, the β activity of the residue was measured. The method is rapid, requiring approximately 4 min per sample. Thallium contents in the range between 1 and 100 ppM can be determined. (auth)

51412 GEOMETRIC FACTORS OF IRRADIATION IN FAST NEUTRON ACTIVATION ANALYSIS. Oblozinsky, P.; Ribansky, I. (Inst. of Physics, Bratislava). Radiochem. Radioanal. Lett.; 7: No. 3, 139-45(1 Aug 1971).

The effects of geometric parameters on the effectiveness of irradiation in fast neutron activation analysis were studied. Both the irradiated sample and the neutron source are assumed to be circular discs. The dependence of the geometric factor on sample orientation and its center position with respect to the source was investigated. Results for a source radius of 0.5 cm and a sample radius of 1.0 cm are presented. (auth)

51413 METHOD FOR THE CHEMICAL SEPARATION OF ^{15}O FROM ^{13}N AND ^{11}C IN GASEOUS SPECIES PRODUCED BY INERT GAS FUSION. Hislop, J. S.; Williams, D. R. (Atomic Energy Research Establishment, Harwell, Eng.). Radiochem. Radioanal. Lett.; 7: No. 3, 129-38(1 Aug 1971).

A method is proposed which overcomes the difficulties associated with the determination of low levels of ^{15}O in the presence of ^{13}N and large amounts of ^{11}C. Use is made of hot Hopcalite as oxidant and absorbant. This simplifies and makes for the more accurate determination of oxygen and nitrogen by γ photon activation followed by inert gas fusion. (auth)

51414 DIURNAL VARIATIONS OF AEROSOL TRACE ELEMENT CONCENTRATIONS AS DETERMINED BY NONDESTRUCTIVE NEUTRON ACTIVATION ANALYSIS. Rahn, K. A.; Dams, R.; Robbins, J. A.; Winchester, J. W. (Univ. of Michigan, Ann Arbor). Atmos. Environ.; 5: No. 6, 413-22(Jun 1971).

XUM

Diurnal concentration variations of 20 trace elements (Al, V, Br, Cl, Na, K, Mg, Ma, Ti, Sm, Eu, La, Ce, Sc, Sm, Zu, Fe, Co, Cr, and Ga) in surface air were studied over a 34 hr period in a rural area. Twenty-five millimetre polystyrene air filter samples were taken each 90 min and analyzed by nondestructive neutron activation analysis using Ge(Li) γ spectrometry and computer assisted data handling. Basic diurnal patterns are related to meterological variables but variations from element to element are ascribed to differences in particle size distributions as determined by an Andersen Cascade Impactor. The behavior and particle size distribution of some elements suggested local sources. (auth) (UK)

51415 NEUTRON ACTIVATION ANALYSIS OF EPITAXIAL SILICON. Larrabee, Graydon B.; Keenan, Joseph A. (Texas Instruments Inc., Dallas). J. Electrochem. Soc.; 118: No. 8, 1351-5(Aug 1971).

A neutron activation analysis technique was developed for the analysis of epitaxial silicon. The technique is described in detail along with a table of detection limits. Impurity and dopant concentrations were profiled through epitaxial films on boron- and antimony-doped substrates. These data along with experience in routine analyses show a factor of 10 to 40 higher impurity concentrations in the outer layer of silicon epitaxial films. Autoradiography combined with profiling was shown to be a powerful tool for studying doping uniformity. (auth)

51416 NICKEL EXPLORATION BY NEUTRON CAPTURE GAMMA RAYS. Senftle, F. E. (U. S. Geological Survey, Washington, D. C.); Wiggins, P. F.; Duffey, D.; Philbin, P. Econ. Geol.; 66: No. 4, 583-90(Jun-Jul 1971).

Studies were made of the application of the neutron capture gamma technique both as a detection and as an analytical tool for nickel. Analysis down to 0.1% nickel generally compares well with the chemical analysis. Measurements using the technique as a detection method were made on an artificially prepared surface deposit of low grade (~1%) nickel ore and also in a test borehole in the same ore. Nickel was easily detected in both cases. (auth)

51417 DETERMINATION OF SURFACE OXYGEN ON SILICON BY A NUCLEAR REACTION. Quaglia, L. (Univ., Liege); Weber, G.; Cuypers, M. Int. J. Appl. Radiat. Isotop.; 22: No. 8, 449-55 (Aug 1971). (In French).

^{16}O(d,p$_1$)^{17}O, ^{16}O(d,α_0)^{14}N and ^{16}O(t,p)^{18}O reactions useful for determination of oxygen content at the surface of silicon were compared and investigated in order to determine their field of interest. (auth) (UK)

51418 PURIFICATION OF SAMPLES FROM SURFACE IMPURITIES FOR THE GAMMA-ACTIVATION DETERMINATION OF OXYGEN, NITROGEN, AND CARBON IN ALKALINE AND ALKALINE-EARTH METALS. Evzhanov, Kh.; Chapyzhnikov, B. A.; Malikova, E. D.; Kunin, L. L. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 26: No. 7, 1373-7(Jul 1971). (In Russian).

In order to ascertain which isotopes were formed by the action of gamma radiation on Na, samples of metallic Na were irradiated in a bremsstrahlung beam of a microton for 6 min. Short-lived ^{21}Na and ^{18}F were detected; these, together with ^{22}Na, lower the sensitivity of determination of O, N, and C in Na. Purification of the surface of the Na as a step in the analytical procedure would help to exclude the effects of surface contamination. Solvents for rapid purification of lithium, sodium, calcium, and magnesium were found, which insure the reproducible (within the accuracy of 10 to 15%) thickness of the metal layer removed by etching. Thus there is no necessity in weighing the samples during the radiochemical isolation of short-lived isotopes. (K.S.W.)

51419 NEUTRON ACTIVATION ANALYSIS OF A STANDARDIZED Al-Si-ALLOY. I. DETERMINATION OF Mn, Cu, AND Ga. Becker, R.; Sorantin, H. (Univ., Vienna. Oesterreichische Studiengesellschaft fuer Atomenergie, Seibersdorf, Austria). Z. Anal. Chem.; 253: No. 5, 347-50(1971). (In German).

An Al-Si-alloy, standardized by NBS, Washington, was activated and the produced, shortlived radionuclides ^{56}Mn, ^{64}Cu, and ^{72}Ga were nondestructively determined by γ spectrometry with a Ge(Li)-detector. The differences between the found and certified values ranged from ±3.5 to 5%. Subsequently the sample was dissolved and the radionuclides separated by a Voltalef column loaded with TOPO. The identification and determination of the chemically isolated radionuclides were performed also by γ spectrometry, using a NaI(Tl)-detector. The values found agreed within ±2% with the standard except the copper content, which showed a positive bias of +3.5%. (auth)

51420 DETERMINATION OF TRACES OF MERCURY IN BIOLOGICAL MATERIAL BY NEUTRON ACTIVATION. Jones, J. D.; Rottschafer, J. M.; Mark, H. B. Jr.; Paulsen, K. E.; Patriarche, G. J. (Univ. of Michigan, Ann Arbor. Univ. of Cincinnati. Univ. Libre, Brussels). Mikrochim. Acta; No. 3, 399-404(1971). (In French).

A simple and rapid technique for the trace analysis of mercury by neutron activation is presented. The activated mercury, as an $HgCl_4^{2-}$ complex, is retained on an anion exchange resin which is counted directly. Results obtained for biological samples containing 10 ppB to 200 ppM are given. In this range, results had a ±10% standard deviation. (auth)

51421 PRECISION SYSTEM FOR THE DETERMINATION OF OXYGEN BY FAST NEUTRON ACTIVATION. Lisovskii, I. P.; Smakhtin, L. A. This paper was summarized in At. Energ. (USSR); 29: No. 6, 450(Dec 1970) as paper No. 449/5820. (In Russian).

A method for determining oxygen from the reaction ^{16}O(n,p)^{16}N is suggested. The samples are irradiated in stainless steel ampoules and the maximum flux at the point of irradiation amounts to $5 \cdot 10^8$ neutrons/cm^2 · sec. The γ emission of the samples and of standards was measured with a detector (NaI(Tl) crystal with a size of 150 mm × 100 mm and with a hole of 20 mm diameter and 50 mm depth) and an LP4050 512-channel analyzer. The ^{16}N activity was measured in the range 4.8 to 8 MeV. Lucite ($C_5H_8O_2$) was used as an oxygen standard. The ampoules were transported in an automated pneumatic shuttle. The irradiation time was 30 sec, the delay time 0.9 sec, and the exposure time 30 sec. The background generated by the ampoule was taken into account. The accuracy of the determinations amounted to 1 to 2.5 relative percent, depending on the oxygen concentration. The sensitivity was 10^{-4} g O_2. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 51543, 51544, 51584, 52291, 52292, 52932, and 52940.

51422 ADVANCES IN MOLTEN SALT CHEMISTRY. VOLUME 1. Braunstein, J.; Mamantov, Gleb; Smith, G. P. (eds.). New York; Plenum Publishing Corporation (1971). 294p. $17.50.

Experimental, theoretical, and applied studies on molten salts are covered. Topics discussed include: vibrational spectroscopy of molten salts, liquid extraction from molten salts, molten salt chemistry of the haloaluminates, molten salt batteries and fuel cells, and thermodynamic studies, by mass spectrometry, of molten mixed halide systems. Author, formula, and subject indexes are included. (M.C.G.)

Chemical Properties

Refer also to abstracts 51597, 52420, and 54159.

51423 (CONF-711001-(Vol.1), pp 315-21) POTENTIOMETRIC TITRATIONS OF YTTERBIUM(II) IN LIQUID AMMONIA AT ROOM TEMPERATURE. Krishnan, R. N.; Warf, James C. (University of Southern California, Los Angeles. Dept. of Chemistry). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

An apparatus for titration in liquid ammonia at room temperature was assembled. This was employed to examine the chemical generation of the ammoniated electron via reduction by Yb(II) in basic solution. The solubility product of $Yb(NH_2)_2$ in liquid ammonia is approximately 1×10^{-10}, and the equilibrium constant for $Yb^{2+} + 3NH_2^- \rightarrow Yb(NH_2)_3 + e_{am}^-$ is of the order 10^{12}. The cyclopentadienide ion precipitates Yb(II) in liquid ammonia, but does not induce oxidation to Yb(III). (auth)

51424 (CONF-711001-(Vol.1), pp 343-58) STUDY BY RADIOCHEMICAL METHODS OF SOME PROPERTIES OF RARE EARTHS. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). 1971. (In French).

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Systematic studies were made of the thermal decomposition of small quantities of rare earth oxides by mass spectrometry. Volatilization of microquantities of rare earth oxides and chlorides was also investigated. Radiochemical polarography, hydrolysis and complex formation, and partition of rare earth nitrates between a fused salt and an organic phase are discussed. (M.C.G.)

51425 (ORNL-TM-3486) THIOCYANATE AND CHLORIDE COMPLEXES OF SOME TRIVALENT ACTINIDES. Harmon, Harry Douglas (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 144p. Dep. NTIS.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The thiocyanate and chloride complexes of some trivalent actinides (Am, Cm, Bk, Cf, and Es) in solutions of both constant and variable ionic strength were investigated by solvent-extraction, spectrophotometric, and anion exchange techniques. When possible, curve-fitting procedures were applied to calculate the various complex stability constants from the experimental data. (D.H.M.)

51426 REACTION BETWEEN $MoOCl_3$ AND UO_2Cl_2. Eliseev, S. S.; Glukhov, I. A.; Vozhdaeva, E. E. (Inst. of Chemistry, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 14: No. 2, 36-9 (1971). (In Russian).

Heating an equimolar mixture of $MoOCl_3$ and UO_2Cl_2 in a sealed tube for 5 hr at 200°C produced MoO_2Cl_2 and $UOCl_3$. Melting point data and chemical analyses confirmed the identity of the products. (K.S.W.)

51427 ISOMERIC URANYL CHELATES WITH DITHIOLATE LIGANDS. Zimmer, L.; Lieser, K. H. (Technische Hochschule, Darmstadt, Ger.). Inorg. Nucl. Chem. Lett.; 7: No. 7, 563-7 (Jul 1971). (In German).

Preparation of tetraethylammonium and tetrapropylammonium complexes with uranyl maleonitrile dithiolate in two isomeric forms is given. Similar compounds with other cations were not preparable by the method used. Solubility, stability, structure, melting point, conductivity, and absorption spectra of the compounds obtained are stated. (UK)

51428 USE OF A ROTATING SINGLE PROBE IN STUDIES OF IONIZATION OF ADDITIVES TO PREMIXED FLAMES. PART 4. THE ALKALINE EARTHS AND URANIUM. Kelly, R.; Padley, P. J. (University Coll., Swansea, Eng.). Trans. Faraday Soc.; 67: No. 581, 1384-96(May 1971).

Total positive ion concentrations N_i produced from Ca, Sr, Ba, and U aqueous salt spray additives in fuel-rich, premixed $H_2 + O_2 + N_2$ flames were quantitatively examined. For the alkaline earths M, the present findings are consistent with the following scheme: $M(OH)_2 + H \rightleftharpoons MOH + H_2O$, $MOH + H \rightleftharpoons MO + H_2$, $MO + H \rightleftharpoons MOH^+ + e^-$, with $M(OH)_2$ the dominant neutral species in the region of measurement. Through a second law procedure, the ionization potentials of CaOH, SrOH and BaOH are deduced to be 5.9 ± 0.1, 5.55 ± 0.1 and 5.25 ± 0.1 eV respectively. With uranium also, the evidence suggests a gaseous scheme, equivalent overall to the above, viz., $UO_nH_m + 3H \rightleftharpoons UO_{n-1}H_{m-1}^+ + e^- + H_2 + H_2O$, with M probably the uranyl species UO_2, i.e., $H_2UO_4 + 3H \rightleftharpoons HUO_3^+ + e^- + H_2 + H_2O$, with $D_0^0(HO - UO_3H) + I.P.\ (HUO_3) = 950 \pm 40$ kJ mol^{-1}, and I.P. $(HUO_3) < 3.9$ eV. When any of these metals are present in the flame together with an alkali metal, N_i may be much greater than predicted if the two additives behaved independently. This effect is consistent with a catalysis of the alkali metal ionization rate by the second additive; the results reveal the possibility of a heterogeneous as well as a homogeneous route. (auth) (UK)

51429 URANIUM(VI) AND URANIUM(IV) WITH HEXAMETHYL PHOSPHORAMIDE. Majumdar, A. K.; Bhattacharyya, R. G.; Bera, D. C. (Jadavpur Univ., Calcutta). Chem. Ind. (London); No. 26, 730(26 Jun 1971).

Hexamethylphosphoramide is known to form complexes with 3d metals and with the lanthanides, and the preparation and physicochemical properties of the uranium complexes are described. The U(VI) compounds were prepared by boiling a uranyl salt with the phosphoramide in dry acetonitrile. It was found that in the chloride, bromide, and nitrato complexes two molecules of the phosphoramide are coordinated, whilst in the thiocyanate complexes two or three molecules of the amide are coordinated, according to the metal-lig and mole ratios employed. A U(IV) compound ($UCl_4 \cdot$ 2HMPA) was prepared in cyclohexanol medium following the preparation method of Majumdar (J. Inorg. Nucl. Chem. 29: 2359(1967)) for UCl_4, $2Ph_3PO$. Details are given of melting point, colour, analysis, magnetic properties, solubility, infrared properties, coordination properties, structure, etc. for $UO_2Cl_2 \cdot$ 2HMPA, $UO_2Br_2 \cdot$ 2HMPA, $UO_2(NO_3)_2 \cdot$ 2HMPA, $UO_2(NCS)_2 \cdot$ 2HMPA, $UO_2(NCS)_2 \cdot$ 3HMPA, $[UO_2(HMPA)_5] \cdot [ClO_4]_2$, and $UCl_4 \cdot$ 2HMPA. (UK)

51430 CRYSTAL STRUCTURE OF TETRAETHYLAMMONIUM OCTATHIOCYANATO-N-URANATE(IV), $[(C_2H_5)_4N]_4[U(NCS)_8]$: AN EXAMPLE OF CUBICAL 8-COORDINATION. Countryman, Rachel; McDonald, W. S. (Univ. of Leeds, Eng.). J. Inorg. Nucl. Chem.; 33: No. 7, 2213-20(Jul 1971).

A single crystal x-ray structure determination shows that in $[(C_2H_5)_4N]_4[U(NCS)_8]$ the eight N-bonded ligands are disposed at the vertices of a cube. Within experimental accuracy no deviations from regular cubical 8-coordination are found. (auth) (UK)

51431 SYNTHESIS OF NEW COMPOUNDS OF NEPTUNIUM (VII) BY THE REACTION OF ALKALI METAL SUPEROXIDES WITH NpO_2. Pages, M. (Institut du Radium, Paris); Nectoux, F.; Freundlich, W. Radiochem. Radioanal. Lett.; 7: No. 3, 155-62(1 Aug 1971). (In French).

Three compounds of neptunium(VII), K_3NpO_5, Rb_3NpO_5, and Cs_3NpO_5, were prepared by direct reaction between NpO_2 and the corresponding alkaline superoxide: $NpO_2 + 3MO_2 \rightarrow M_3NpO_5 + {}^3/_2O_2\uparrow$. Their thermal decomposition yields neptunium(VI) compounds, M_2NpO_4, with tetragonal structure, isostructural with M_2UO_4. (auth)

51432 SYNTHESIS OF $Th(ReO_4)_4$ AND $Np(ReO_4)_4$. Silvestre, Jean-Paul; Pages, Monique; Freundlich, William (Univ., Paris. Institut du Radium, Paris). Compt. Rend., Ser. C; 272: No. 22, 1808-10(2 Jun 1971). (In French).

$Th(ReO_4)_4$ and $Np(ReO_4)_4$ were prepared, either by the reaction of Re_2O_7 (vapor) with ThO_2 and NpO_2 at high temperatures in a sealed tube, or the reaction of $HReO_4$ on various thorium and neptunium salts in aqueous medium. Various hydrates were identified. (France)

51433 AMERICIUM DISULPHIDE AND DISELENIDE. Damien, D.; Jove, J. (CEN, Fontenay-aux-Roses, France). Inorg. Nucl. Chem. Lett.; 7: No. 7, 685-8(Jul 1971).

These compounds were prepared on the 50 mg. scale by vapor phase reaction of excess S or Se with ^{241}Am hydride in a pyrene tube. The tube was loaded in a dry Ar glove box and sealed under high vacuum. The reaction was allowed to proceed at 400°C for a week, during which time one end of the tube was kept at 300°C. The products appeared as a black and rather coarse material. X-ray studies were carried out in pyrene capillaries. Both compounds could be indexed in the quadratic system with a c/a ratio near two. The lattice parameters were disulphide a = 3.938 ± 0.002Å, c = 7.981 ± 0.005Å, diselenide a = 4.096 ± 0.002Å, c = 8.347 ± 0.005Å. The compounds could be described by the Fe_2As pseudo-cell, like the corresponding non-stoichiometric Pu compounds ($PuS_{1.9}$ and Pu $Se_{1.8}$), and it can be assumed that the Am compounds have composites near $AmS_{1.9}$ and $AmSe_{1.8}$. Comparisons are made with the lanthanide compounds. The Am−S and Am−Se interatomic distances were 2.93 and 2.06Å, respectively, in good agreement with an ionic binding between Am^{3+} and $S^=$ or $Se^=$. (UK)

51434 MAGNETIC SUSCEPTIBILITIES OF THE TETRAVALENT PLUTONIUM ION IN OCTAHEDRAL COMPOUNDS. Karraker, D. G. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Inorg. Chem.; 10: No. 8, 1564-6(Aug 1971).

The magnetic susceptibilities of Pu^{4+} in $[(CH_3)_4N]_2PuCl_6$, $[(C_2H_5)_4N]_2PuCl_6$, and Cs_2PuCl_6 were measured from 2.5 to 50°K with a Foner-type vibrating-sample magnetometer. The Pu^{4+} ion in $[(CH_3)_4N]_2PuCl_6$ showed temperature-independent susceptibility from 2.5 to 3°K and a Curie−Weiss temperature dependence from 3 to 50°K with $\mu_{eff} = 1.92$ BM and $\Theta = 5.45°K$. In $[(C_2H_5)_4N]_2$ $PuCl_6$, the Pu^{4+} magnetic susceptibility was temperature independent from 2.5 to 4.5°K and had Curie−Weiss temperature dependence from 4.5 to 50°K, with $\mu_{eff} = 1.95$ BM and $\Theta = 10.7°K$. These and earlier measurements were employed to deduce that the $^5I_4$ ground manifold of Pu^{4+} has a Γ_1 ground level and that the splitting of the Pu^{4+} ground state is about 145 cm^{-1}. The paramagnetic temperature dependence of Pu^{4+} in Cs_2PuCl_6 at low temperature is attributed to a distortion of the $PuCl_6^{2-}$ octahedron that produces a non-Kramers doublet at the lowest level. (auth)

51435 DIPHENYL SULPHOXIDE COMPLEXES OF THORIUM(IV). Savant, V. V.; Patel, C. C. (Indian Inst. of Science, Bangalore). J. Less-Common Metals; 24: No. 4, 459-65(Aug 1971).

Thorium(IV) is known to form high coordination-number complexes. An attempt was made to determine the effect of anions on the coordination complexes of diphenyl sulphoxide (DPSO) with thorium(IV). The complexes formed have the formulae $[Th(DPSO)_6](ClO_4)_4$, $[Th(DPSO)_4Cl_4]$, $[Th(DPSO)_4Br_4]$, $[Th(DPSO)_6I_2]I_2$, $[Th(DPSO)_4(NCS)_4]$, and $[Th(DPSO)_3(NO_3)_4]$. In all the complexes, DPSO is coordinated to the metal ion through its oxygen. The electrical conductances in nitrobenzene and in nitromethane, and ebullioscopic molecular weights in acetonitrile, show that the perchlorate and iodide complexes behave as 1 : 4 and 1 : 2 electrolytes, respectively; while the other complexes are monomeric and nonelectrolytes. The infrared spectra of the solid complexes indicate the ionic nature of the perchlorate, the bidentate nature of the nitrate and the coordination of the thiocyanate through its nitrogen. $[Th(DPSO)_4Cl_4]$, $[Th(DPSO)_4Br_4]$, and $[Th(DPSO)_3(NO_3)_4]$ decompose endothermically while $[Th(DPSO)_6](ClO_4)_4$ and $[Th(DPSO)_4(NCS)_4]$ decompose exothermically, both in air and in nitrogen. The perchlorate complex has octahedral symmetry around the thorium, the halo- and the

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thiocyanato complexes are 8-coordinate, probably with square antiprismatic structures, while the nitrate complex is 11-coordinate. (auth)

51436 STUDIES ON OCTACYANOGEN COMPLEXES. PART I. COMPOSITION AND STABILITY OF URANYLMOLYBDOCYANIDE COMPLEX ION. **Joshi, D. P.; Sharma, K. N. (D. A. V. Coll., Muzaffarnagar, India). Z. Phys. Chem. (Leipzig); 246: No. 5-6, 281-91(1971).**

Composition and stability of the brown-red uranylmolybdocyanide ion were studied in aqueous medium. The absorption spectra at different pH suggest that the complex is stable in the pH range 2.2 to 3.8. The Vosburgh and Cooper extension of Job's method of continuous variations shows that in the optimum pH range only one complex ion is present. Application of Job's method of continued variation, slope ratio, and mole ratio establishes that the mole ratio of molybdocyanide to uranyl in this complex ion is 1:1. Conductometric studies using Job's and monovariation method confirm 1:1 ratio. The average value of the dissociation constant, for the equilibrium $UO_2Mo(CN)_8^{-2} \rightleftharpoons UO_2^{++} + Mo(CN)_8^{-4}$, as evaluated by different methods was found to be 10.76×10^{-4} at 30°. The value of ΔF^0 for the complex at 30° is −4.128 kcal per mole. A tentative structure for the complex is suggested. (auth)

51437 REACTIONS OF ETHYLENE AND ACETYLENE AT THE SURFACE OF SOLUTIONS OF BARIUM IN LIQUID SODIUM. **Addison, C. C.; Hobdell, M. R.; Pulham, R. J. (Univ. of Nottingham, Eng.). J. Chem. Soc., A; No. 11, 1708-11(1971).**

The addition of barium to liquid sodium modifies the reactions of the liquid metal with simple hydrocarbons. The reactions of 4.6 at. % solutions of barium in liquid sodium with acetylene and ethylene were studied at 100, 150, and 200°C and at starting pressures up to 18 cmHg. Ethylene reacts with this solution to give a solid acetylide and hydrogen, but hydrogenation to ethane also occurs to a small extent. Reaction of acetylene is much slower (by a factor of about 50) than with liquid sodium alone. Breaks in pressure–time curves are interpreted in terms of adsorption and reaction of acetylene, ethylene, and hydrogen at the metal surface. (auth)

51438 REACTIONS OF ACETYLENE AND PROPYNE AT THE SURFACE OF LIQUID SODIUM. **Addison, C. C.; Hobdell, M. R.; Pulham, R. J. (Univ. of Nottingham, Eng.). J. Chem. Soc., A; No. 11, 1704-8(1971).**

The reactions of acetylene and propyne at the surface of liquid sodium were studied at 110, 150, and 200°C. A fresh metal surface was maintained by magnetic stirring, so arranged that the metal poured continuously over a baffle plate. The course of the reactions was followed from pressure–time curves, and the ir spectra of the gas phase. At 110°C, propyne reacts smoothly according to equation $3\ MeC \equiv CH + 2\ Na \rightarrow 2\ NaC \equiv CMe + MeCH = CH_2$ and all hydrogen atoms produced at the surface of the metal are employed in the hydrogenation of propyne to propene. A smaller effect (probably polymerization) also becomes evident at 200°C. The behavior of acetylene is markedly different, and the reaction proceeds in two stages. In the first, disodium acetylide (but no hydrogen acetylide) is formed, and the gas phase consists of hydrogen and ethylene in the ratio 1.42:1 at 150°C. No ethane was detected. The second stage involves reaction of hydrogen with sodium metal, and this does not commence until all acetylene is removed from the gas phase. The results are discussed qualitatively in terms of the relative absorption of the gases at the sodium surface, which may have some analogies with their absorption coefficients at transition-metal surfaces. (auth) (UK)

Isotope Effects and Exchange

Refer also to abstracts 51495, 51525, 51569, and 51601–51603.

51439 SECONDARY α-DEUTERIUM ISOTOPE EFFECT STUDY OF THE DIELS–ALDER TRANSITION STATE. Taagepera, Mare. Philadelphia; Univ. of Pennsylvania (1970). 74p. University Microfilms Order No. 71-19,289.

Thesis.

Secondary α-deuterium isotope effects were studied in the reverse Diels–Alder reaction of 9,10-dihydro-9,10-ethanoanthracene, and its -11,11-d_2 and -11,11,12,12-d_4 derivatives, in an effort to determine the symmetry of the Diels–Alder transition state. The average isotope effect at 219.84 ± 0.015° for k_2/k_0 = 0.924 ± 0.005, and the average isotope effect for k_4/k_0 = 0.852 ± 0.007. The difference between the mechanistic extremes was 0.6%. (Diss. Abstr. Int., B)

51440 NORMAL COORDINATE CALCULATIONS OF THE VIBRATIONS OF METHYLENE CYCLOPROPANE-h_6 AND -d_6. **Bertie, J. E.; Norton, M. G. (Univ. of Alberta, Edmonton). Can. J. Chem.; 49: 2229-41(1 Jul 1971).**

Normal coordinate calculations for methylene cyclopropane-h_6 and -d_6 were carried out using two models. In the first model 31 internal coordinates were used, and in the second model 25 internal coordinates were used. The force constants were, in each case, refined to the 40 frequencies observed for the two molecules. Using the first model 26 force constants, of which four were constrained, fitted the frequencies with an average error of 1.2% for C_4H_6 and 2.8% for C_4D_6. Using the second model 24 force constants, of which two were constrained, fitted the frequencies with an average error of 1.4% for C_4H_6 and 2.8% for C_4D_6. The very low isotopic shift of the C=C stretching mode can be explained by an interaction with the ethylenic CH_2 deformation, which is best assigned at 1047 cm^{-1}, rather than at 1139 cm^{-1}, in C_4D_6. The calculations indicate that the experimental assignment for the A_1 ring breathing mode and the A_1 methylenic wag in C_4H_6 should probably be reversed. For the A_1 and the B_1 modes with frequencies between 500 and 1300 cm^{-1}, the normal coordinates change considerably on deuteration. The symmetry coordinates are mixed in the normal modes of C_4D_6 to a much greater extent than in those of C_4H_6. (auth) (Canada)

51441 MICROWAVE SPECTRUM, VIBRATION-ROTATION INTERACTION, AND RING PUCKERING VIBRATION IN SILACYCLOBUTANE AND SILACYCLOBUTANE-1,1-d_2. **Pringle, Wallace C. Jr. (National Bureau of Standards, Washington, D. C. Wesleyan Univ., Middletwon, Conn.). J. Chem. Phys.; 54: No. 12, 4979-88(15 Jun 1971).**

The microwave spectrum of the molecules silacyclobutane and silacyclobutane-1, 1-d_2 was observed between 8 and 55 GHz and the first four vibrational states assigned. The ground state rotational constants of the former molecule are 8815.75, 6289.00, and 4245.32 MHz. The first two inversionlike intervals of the ring puckering mode were determined to be 75.75 and 7790 MHz in the normal isotopic species; the corresponding intervals in the deuterated species are 43.06 and 4430 MHz. The effect of these frequencies on the determination of the potential energy for the ring puckering vibration was investigated. The ring configuration was shown to be significantly puckered in the ground state. The a component of the dipole moment was found to be nearly constant in the four vibrational states of the normal molecule, μ_a = 0.4396 D, while the out-of-plane transition moment between inversion doublets dropped rapidly as the inversion levels approached the top of the barrier. (auth)

51442 PHOTOIONIZATION MASS SPECTROMETRIC STUDY OF F_2, HF, AND DF. **Berkowitz, J.; Chupka, W. A.; Guyon, P. M.; Holloway, J. H.; Spohr, R. (Argonne National Lab., Ill.). J. Chem. Phys.; 54: No. 12, 5165-80(15 Jun 1971).**

From an analysis of the threshold region for formation of F_2^+ by photoionization of F_2, the value 15.686 ± 0.006 eV was deduced as the first ionization potential. The process $F_2 + h\nu \rightarrow F^+ + F^-$ begins at slightly lower energy and is traced to Landau–Zener-type crossing from certain Rydberg states to a potential curve leading to the separated ions in their ground states. The Rydberg states are those converging to the ground state of F_2^+, $^2\Pi$. The ion-pair process is still significant at higher energy, in the vicinity of the threshold for the process $F_2 + h\nu \rightarrow F^+ + F + e$. Subtracting the intensity of F^- from that of F^+ in this energy region yields a corrected threshold of 19.01 eV, which gives $D_0(F_2)$ = 1.59 ± 0.01 eV. The photoionization of HF (and DF) also gives rise to these three prominent processes, i.e., parent ionization, pair formation, and dissociative ionization. The ionization potential is found to be 16.00_7 ± 0.01 eV for HF (16.03_0 ± 0.01 eV for DF). The corrected threshold for H^+ is 19.44_5 eV (19.51_3 eV for D^+) which gives $D_0(HF) = 5.84_5$ ± 0.01 eV. Quantitative descriptions are given for the autoionization peaks observed in both the F_2 and HF spectra. (auth)

51443 MICROWAVE SPECTRUM OF ACETIC ACID, CH_3COOH AND CD_3COOH. **Krisher, Lawrence C.; Saegebarth, Ellen (Univ. of Maryland, College Park). J. Chem. Phys.; 54: No. 11, 4553-8(1 Jun 1971).**

The microwave spectra of two isotopic species of acetic acid, CH_3COOH and CD_3COOH, were re-examined. Using the principal axis method and a computer program extended to include terms through n = 6 in the perturbation series and denominator corrections, 30 new E-type transitions were identified. For CH_3COOH, an excellent fit of the observed A–E splittings is obtained using the parameters $I_\alpha = 3.216 \pm 0.002$ amu · Å^2, $\theta = 4°30' \pm 15'$ for the angle between the methyl group axis and the a principal axis, and s = 13.232 ± 0.002. Assigned splittings are very large (up to 3600 MHz), and the calculated spectrum is sensitive to all three parameters. The value for the barrier to internal rotation of the methyl group is V_3 = 480.8 ± 0.5 cal/mole for CH_3COOH, and 468 ± 2 for CD_3COOH. Stark effect measurements using four A-type transitions give the dipole moment components: μ_a = 0.86 ± 0.01 D, μ_b = 1.47 ± 0.02 D, and μ = 1.70 ± 0.02 D. (auth)

51444 MICROWAVE SPECTRUM OF BROMOSTANNANE, SnH_3Br. Wolf, Stephen N.; Krisher, Lawrence C.; Gsell, Ray A. (Univ. of Maryland, College Park). J. Chem. Phys.; 54: No. 11, 4605-11(1 Jun 1971).

Pure rotational measurements were made on nine isotopic species of the unstable symmetric-top molecule bromostannane, SnH_3Br, using a microwave spectrometer. The Sn–Br bondlength is 2.4691 ± 0.0003 Å. Quadrupole hyperfine structure due to the bromine nuclei gives values of eQq (^{79}Br) = 350 ± 6 MHz and eQq (^{81}Br) = 291 ± 6 MHz. A centrifugal-distortion constant, D_{JK} = 0.0069 ± 0.0004 MHz affords a best fit to the complex K structure of observed transitions. (auth)

51445 FAR-INFRARED AND RAMAN SPECTRA OF SOLID METHANOL AND METHANOL-d_4. Durig, J. R.; Pate, C. B.; Li, Y. S.; Antion, D. J. (Univ. of South Carolina, Columbia). J. Chem. Phys.; 54: No. 11, 4863-70(1 Jun 1971).

The far-infrared and Raman spectra were obtained of methanol and methanol-d_4 at –185°C, and a temperature-dependence study of the Raman spectrum was carried out. In the low-temperature α phase, splitting of the C–O stretching mode was observed in the Raman spectrum but disappeared when the sample was warmed to the high-temperature β phase. The coalescence of this band is attributed to the disorder caused by the interchange of the methyl groups above and below the plane of the chain. Four bands were observed at 350, 167, 109, and 57 cm^{-1} in the low-frequency infrared spectrum of methanol, which shifted to 325, 161, 97, and 61 cm^{-1} with deuteration. One skeletal mode was observed at 196 cm^{-1} in the Raman effect and shifted to 180 cm^{-1} with deuteration. It is shown that the spectra arising from the skeletal motions can be interpreted on the basis of line-group theory in which the line-group factor group is proposed to be C_2 for both phases. Also the nature of the molecular motions giving rise to the low-frequency bands is discussed in relation to the observed shift factors with deuteration. Possible assignments for the skeletal modes is also given in terms of the factor group of the $C_2^2-P_{2_1}$ space group, but the other suggested space group $C_{2h}^2-P_{2_1/m}$ is not consistent with the number of observed far-infrared bands. (auth)

51446 STUDY OF THE VIBRATIONAL SPECTRA OF ISOTHIAZOLE AND THE INFRARED SPECTRA OF THREE MONO AND DIDEUTERIO ISOTHIAZOLES. Meyer, Jean-Louis (Centre Technique de Spectroscopie Infrarouge, Marseille); Davidovics, Giselle; Chouteau, Jacques; Poite, Jean-Claude; Roggero, Jean. Can. J. Chem.; 49: 2254-65(1 Jul 1971). (In French).

The 4- and 5-monodeuterio and 4,5-dideuterio isothiazoles were prepared and their ir spectra recorded in different states. The Raman spectrum of isothiazole was also measured; its analysis led to modification of the assignment of two of the fundamental modes previously described for this compound. The analysis of the ir spectra of the three deuterio isothiazoles is discussed. (auth) (Canada)

51447 SECONDARY AND SOLVENT ISOTOPE EFFECTS ON THE PARTITIONING OF ION PAIR INTERMEDIATES. Donnelly, Michael Francis. Baltimore; Johns Hopkins Univ. (1970). 139p. University Microfilms Order No. 71-16,719.

Thesis.

The diphenyldiazomethane reaction with benzoic acid and solvent ethanol was used to probe the existence of a possible secondary α-tritium isotope effect on the partitioning of ion pairs, a situation frequently encountered in solvolysis. Using benzoic acid–O–t, tritium activities of ester and ether products were measured. The ratio A_{ester}/A_{ether} is 1.16; in 90% acetone the ratio $A_{ester}/A_{alcohol}$ is 1.14. The results reveal a substantial partitioning isotope effect (PIE). The close agreement of the isotope effects in the two solvents (where extent of external ion-pair return varies greatly) is interpreted as an indication that the PIE occurs predominantly at the tight ion-pair stage. The isotope effects on ethanolysis and hydrolysis of benzhydryl-α-t benzoate were also measured. They are 1.22 at 100° and 1.16 at 140°, respectively. Coupled with the PIE, these numbers allow direct calculation of the ionization isotope effect, k_1^D/k_1^H. For benzhydryl-α-d benzoate the ionization isotope effect is 1.12, substantially lower than the solvolysis isotope effect. The variation of α-deuterium isotope effects with reaction conditions is discussed in terms of the PIE. Predictions of extrema are the maximum solvolytic isotope effect for rate-determining dissociation of tight ion pair and the minimum for rate determining formation of tight ion pair. The implication of calculating internal return in an S_N1 process from solvolytic isotope effect was explored. (Diss. Abstr. Int., B)

51448 KINETICS OF ACID-CATALYZED HYDROGEN ISOTOPE EXCHANGE IN THIOPHENE, FURAN, SELENOPHENE, AND PYRROLE, AS WELL AS FURAN HYDROLYSIS. Schwetlick, Klaus; Unverferth, Klaus (Technical Univ., Dresden). Wiss. Z. Tech. Hochsch. Chem. Leuna-Merseburg; 12: No. 3-4, 230(1970). (In German).

H–D exchange in selectively 2- and 3-deuterated heterocycles was a 1st order reaction with the relative reactivities C_6H_6 1, thiophene-3-d 1 × 10^4, thiophene-2-d 2 × 10^7, furan-2-d 3 × 10^7, selenophene-2-d 2 × 10^8, pyrrole 1 × 10^{15}. Furan-3-d and selenophene-3-d decomposed faster than the H–D exchange took place. Acid hydrolysis of furan proceeds via the protonation of the 2-position. (Selenium-Tellurium Abstr.)

51449 HYDROGEN DISPLACEMENT IN n-BUTANE BY FAST T_2 AND T_2^+ COLLISIONS. Beatty, J. W.; Wexler, S. (Argonne National Lab., Ill.). J. Phys. Chem.; 75: No. 16, 2417-26 (5 Aug 1971).

The translational energy dependences of the formation of tritiated n-butane resulting from collisions of beams of fast T_2 molecules and of T_2^+ ions with a crossed sheath of n-butane molecules were measured with a "chemical accelerator." For the neutral–neutral collisions the hydrogen displacement reaction possesses a threshold of 6.0 ± 0.6 eV (laboratory system) and the reaction probability rises to a maximum near 30 eV and then remains constant as the kinetic energy of the T_2 molecules is raised to 100 eV. The observed onset energy indicates that the lowest energy observable reaction involves displacement of a hydrogen atom in the butane molecule by a tritium atom from the fast T_2 molecule with concurrent release of the second tritium and the displaced hydrogen as atoms. The reaction probability for T_2^+ impinging on n-C_4H_{10} decreases rapidly as the energy of the ion is raised from 5 to 20 eV, remains fairly constant up to 40 eV, and then shows a broad peak centered at about 60 eV. The shape of the yield curve suggests that there are two translational energy dependent mechanisms involved. Below ~20 eV T_2^+ energy, the most likely mode indicated is proton transfer followed by loss of H_2 and hydride transfer. At higher energies collisional dissociation followed by tritium pickup is suggested. (auth)

51450 THEORY OF VIBRATIONAL–ROTATIONAL ENERGY TRANSFER PROCESSES. Hess, Peter (Univ., Heidelberg). Ber. Bunsenges. Phys. Chem.; 75: No. 6, 592-6(Jun 1971). (In German).

A theory for the vibrational-rotational energy transfer process is derived from the assumption that this process is determined by the ratio of the time of rotation to the time of vibration. The effect of isotopic substitution on the transition probabilities is described properly in the systems CH_4-CD_4, SiH_4-SiD_4, PH_3-PD_3, AsH_3-AsD_3 and $C_2H_4-C_2D_4$. Great discrepancies appear in the system NH_3-ND_3 only. The example of methane was chosen to show that the theory gives the correct temperature dependence of the transition probabilities. The influence of the intermolecular forces is contained in a constant factor, which is perhaps influenced by other effects too. (auth)

51451 INTERMOLECULAR COUPLING OF WATER MOLECULES IN COPPER CHLORIDE DIHYDRATE. Fifer, R. A.; Schiffer, J. (Temple Univ., Philadelphia). J. Chem. Phys.: 54: No. 12, 5097-5102(15 Jun 1971).

Polarized and unpolarized infrared spectra were obtained for copper chloride dihydrate samples containing low mole ratios of H_2O and D_2O. The positions of the absorption bands of these samples are shown to differ from those of samples containing high percentages of these same molecules. The spectral differences noted are shown to be related to the interactions between water molecules in the solid. Furthermore, a criterion is provided for sensing a variation of hydrogen bond strength with deuteration, and the origin of bands in the ν_2 overtone regions of H_2O, D_2O, and HOD is also considered. (auth)

51452 CATALYSIS OF THE ISOTOPE EXCHANGE REACTION $HTO + H_2 \rightarrow HT + H_2O$ ON THE INTERMETALLIC COMPOUND NiGa. Best, K. J.; Grabke, H. J. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Ber. Bunsenges. Phys. Chem.; 75: No. 6, 524-32(Jun 1971). (In German).

At temperatures above 500°C the isotope exchange reaction $HTO + H_2 = HT + H_2O$ was studied in flowing H_2O-H_2 mixtures on Ni and Fe and on alloys from the homogeneity range of the intermetallic compound NiGa. In the homogeneity range of NiGa between 49 and 56 a/o Ga there are considerable changes of the Fermi energy, of the concentration of point defects and of the adsorptive properties, the correlation of these properties and of the catalytical properties of NiGa is discussed. From the dependence of the reaction rate on the oxygen activity $a_0 = p_{H_2O}/p_{H_2}$ evidence on the adsorption equilibrium $H_2O = H_2 + O(ad)$ can be derived, the enthalpy and entropy of oxygen adsorption on the studied metals

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could be determined. Reversible changes of the surface structure (striation) and of the reaction kinetics were observed on iron in a range of high oxygen activity, similar irreversible changes were observed on NiGa. (auth)

51453 CHEMICAL REACTION KINEMATICS. XIV. THE ANGULAR AND VELOCITY DISTRIBUTIONS FOR THE REACTION $O_2^+ + D_2 \rightarrow O_2D^+ + D$ AND THE ISOTOPE EFFECT FOR THE REACTION WITH HD. Bosse, G.; Ding, A.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges. Phys. Chem.; 75: No. 5, 413-20(May 1971). (In German).

The reaction of O_2^+ ($^2\Pi_g$) with D_2 proceeds via a relatively long lived complex at low incident ion energies and via an impulsive mechanism at high energies. These results were obtained by measuring the energy and angular distributions of the O_2D^+ product ion at various energies. Some of the properties of the complex formed at 28 eV (lab. system) are discussed. The complex is formed with a relatively low cross section. Its fragments are frequently formed with much translational energy. They carry little orbital momentum. The O_2D^+ ion is isotropically scattered in the cm-system. The O_2D^+ ion from the reaction of $O_2^+(^4\Pi_u)$ with D_2 is strongly forward scattered. The most probable velocity of this product amounts to 0.962 times the velocity of the incident O_2^+ ion, which corresponds to a process without any change in the translational energy (i.e., the internal energy of the product ion is equal to the heat of reaction). It is shown that no long lived intermediate complex can exist here. A stripping reaction is (with the exception of low energies) only possible if a strong repulsion occurs between the D atoms of the D_2 molecule during the reaction or if the products repel each other (recoil stripping). The repulsion may partly be due to the parallel spin alignment of the products. The distributions of the translational energy of the products O_2H^+ and O_2D^+ from the reactions of both states of O_2^+ with HD were also measured. The contributions of the complex and the recoil stripping mechanisms to these distributions are different for O_2H^+ and O_2D^+. This isotope effect can easily be understood by the different collision models proposed for the reactions of the two states of O_2^+. (auth)

51454 LATTICE VIBRATIONAL SPECTRA. VIII. IR AND FIR SPECTRA OF BARIUM AND STRONTIUM HALOGENIDE MONOHYDRATES. Lutz, H. D.; Klueppel, H.-J.; Feher, M.; Bursian, S. (Univ., Cologne). Ber. Bunsenges. Phys. Chem.; 75: No. 6, 583-8(Jun 1971). (In German).

The IR-spectra (33–4000 cm^{-1}) of the halide monohydrates: $SrCl_2 \cdot H_2O$, $SrBr_2 \cdot H_2O$, $SrI_2 \cdot H_2O$, $BaCl_2 \cdot H_2O$, $BaBr_2 \cdot H_2O$ and $BaI_2 \cdot H_2O$ as well as the deuterated and partial deuterated compounds are communicated. The absorption maxima are assigned on the basis of the factor group. The force constants from the internal vibrations of the water molecules show that the strength of the OH bonds (valence force constants) is dependent on the quantity of the cation field, while the bending constants are chiefly influenced by the weak hydrogen bondings to the halide ions. The lattice vibrations of the alkaline earth halide monohydrates, which vibrational modes were taken from the symmetry coordinates, were shifted to larger wavenumbers from strontium to barium compounds, notwithstanding that the mass of the metal ions increases. (auth)

51455 MECHANISM OF A RATE-CONTROLLED CROSS-DISPROPORTIONATION BETWEEN PHENOXYL RADICALS. Adam, Waldemar; Chiu, Wen Tzong (Univ. of Puerto Rico, Rio Piedras). J. Amer. Chem. Soc.; 93: No. 15, 3687-93 (28 Jul 1971).

The reaction of galvinoxyl with trihydrogalvinoxyl leads to hydrogalvinoxyl in the stoichiometric proportions of 2 : 1 : 3, respectively. The experimental rate law, measured by following the decay of the galvinoxyl ESR signal, was found to be second order in galvinoxyl, first order in trihydrogalvinoxyl, and inverse order in hydrogalvinoxyl. The activation parameters were $\Delta H^\ddagger = 7.7$ kcal/mol and $\Delta S^\ddagger = -42.8$ gibbs/mol, indicating that steric congestion is the principal factor in the rate-limiting step. The isotope effect for hydrogen transfer from carbon to oxygen was found to be 3.6, but no isotope effect for hydrogen transfer from oxygen to oxygen was observed. This implies that the methylene hydrogen of trihydrogalvinoxyl rather than the hydroxyl hydrogen is transferred in the slow step. Although the free energy of activation and thus the rates of hydrogen transfer were constant in a large number of diverse solvents, it was found that $\Delta H^\ddagger$ and $\Delta S^\ddagger$ for the hydrogen transfer in benzene, acetone, acetonitrile, and cyclohexane followed a linear relationship with an isokinetic temperature of 293.8°K. The mechanism is discussed in terms of initial fast reversible oxygen–oxygen hydrogen transfer between galvinoxyl and trihydrogalvinoxyl, followed by rate-controlled cross-disproportionation between galvinoxyl (G) and the dihydrogalvinoxyl (GH_2) radical. (auth)

51456 STEREOCHEMISTRY OF BASE-CATALYZED β ELIMINATION FROM 2-BROMOBUTANE. Bartsch, Richard A. (Washington State Univ., Pullman). J. Amer. Chem. Soc.; 93: No. 15, 3683-6(28 Jul 1971).

The stereochemistry of β elimination from d,l-erythro- and d,l-threo-3-deuterio-2-bromobutane (1 and 2, respectively) induced by a variety of base-solvent combinations was determined. Both cis- and trans-2-butene are formed by exclusive anti elimination with EtOK–EtOH, sec-BuOK–sec-BuOH, tert-BuOK–tert-BuOH, tert-BuOK–DMSO, tert-BuOK–THF, and $n\text{-}Bu_4NF$–DMF. Within experimental error, equal primary deuterium isotope effects were observed for the formation of trans-2-butene from 1 and cis-2-butene from 2 in a given base-solvent system. (auth)

51457 KINETIC DEUTERIUM ISOTOPE CRITERION FOR CONCERTEDNESS. Kwart, Harold; Latimore, Margaret C. (Univ. of Delaware, Newark). J. Amer. Chem. Soc.; 93: No. 15, 3770-1(28 Jul 1971).

A study was made to test the validity of the kinetic deuterium isotope criterion that involved measuring the k_H/k_D as a function of temperature in the thermolysis of 4-penten-2-ol, 3-butenoic acid, and 3-butyn-1-ol. The three reactions show about the same rates at all temperatures despite the very considerable range of substituent and structural variations. Results appear to answer most doubts and qualification of the validity of the kinetic deuterium isotope criterion. They confirm the absence of any serious effects from change in hybridization and valence geometry of the carbon to which H is transferred. (D.H.M.)

51458 ENOLIC $C_3H_6O^{\cdot +}$ ION FORMED FROM ALIPHATIC KETONES. McLafferty, F. W.; McAdoo, D. J.; Smith, James S.; Kornfeld, Richard (Cornell Univ., Ithaca, N. Y.). J. Amer. Chem. Soc.; 93: No. 15, 3720-30(28 Jul 1971).

Contrary to previous postulations, the ubiquitous enolic $C_3H_6O^{\cdot +}$ ion found in ketone mass spectra decomposes mainly by rearrangement to an unstable acetone ion, not by simple cleavage loss of the methyl group. A methyl hydrogen can also rearrange through a four-membered ring intermediate to the methylene group, and both reactions exhibit substantial primary isotope effects. All six hydrogen atoms show nearly equivalent secondary isotope effects on the relative rates for the losses of the two methyl groups, consistent with their loss from the intermediate acetone ion. An unusual observation is that the two methyl groups are lost from this intermediate acetone ion at unequal rates; it is suggested that this is due to incomplete randomization of energy before decomposition. Apparently this is the first case reported in which ion fragmentation is not independent of initial preparation. The fragmentations of isotopically labeled $C_3H_6O^{\cdot +}$ ions formed by the double hydrogen rearrangement of alkanones closely resemble the behavior of the enolic $C_3H_6O^{\cdot +}$ ions. This provides independent verification of the recent ion cyclotron resonance evidence of Djerassi and coworkers which shows that these double rearrangement ions have the enolic structure, in contrast to the oxonium ion structure postulated originally. (auth)

51459 HYDRIDE DERIVATIVES OF NIOBOCENE AND TANTALOCENE. Tebbe, F. N.; Parshall, G. W. (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Amer. Chem. Soc.; 93: No. 15, 3793-5(28 Jul 1971).

A method for the preparation of $(C_5H_5)_2NbH_3$ is presented and some of its chemical properties are discussed. It was found that $(C_5H_5)_2NbH_3$ will catalyze the H–D exchange between hydrogen and C_6D_6. (D.H.M.)

51460 INTRAMOLECULAR ISOTOPE EFFECT IN THE ACID DECOMPOSITION OF CARBONATES. Pandey, G. C.; Pillai, N. V.; Sharma, T. (Indian Inst. of Tech., Kanpur). Z. Phys. Chem. (Leipzig); 246: No. 5-6, 297-302(1971).

The ^{18}O intramolecular isotope effects in the acid decomposition of carbonates of Mn, Zn, Cd, and Pb were calculated over a temperature range of 25 to 62°C. It was found that the isotope effect varies inversely with the temperature and at a particular temperature the isotope effect increases with the increase in the atomic weight of the metal in carbonates except for $PbCO_3$. This difference in behavior of $PbCO_3$ was attributed to its basic nature. The experimental temperature independent factor (TIF) values were calculated and found to be in good agreement with those obtained from Slater's approximation. The isotope effect associated with the alkaline earth and the above carbonates were compared and the differences were attributed to the difference in the nature of bonding. (auth)

51461 FREE-VOLUME DEPENDENCE OF RELAXATION TIME AND VISCOSITY IN WATER AND HEAVY WATER. Rizk, H. A. (Univ. of Cairo). Z. Phys. Chem. (Leipzig); 246: No. 5-6, 396-402(1971).

Comparison, within the temperature range 20 to 50°C, between the "free-volume" values in water, as calculated from either relaxation time or viscosity data, and those of unbonded water molecules, as calculated from Némethy-Scheraga model, indicates an empirical correlation between the relaxation time, as well as viscosity and the structure of water defined by this model. It is suggested that the occurrence of a single relaxation time in water, light or heavy, is due to the molecular rotation in the unbonded species, and that the relaxation time is a function of either the fraction of hydrogen bonds unbroken or that of unbonded molecules in this model. Estimates of τ on this basis are found to be in fair agreement with those observed. (auth)

51462 TRITIUM ISOTOPE EFFECTS IN THE OXIDATION OF 1,2,3,4-TETRAHYDRO-(1-^{3}H)NAPHTHALENE TO (1-^{3}H)NAPHTHALENE BY 2,3-DICHLORO-5,6-DICYANO-QUINONE (DDQ). **van der Jagt, P. J.; de Haan, H. K.; van Zanten, B. (Free Univ., Amsterdam). Tetrahedron; 27: No. 14, 3207-14(Jul 1971).**

The dehydrogenation of 1,2,3,4-tetrahydronaphthalene (tetralin) to naphthalene with 2,3-dichloro-5,6-dicyanoquinone (DDQ) involves 1,2-dihydronaphthalene as an intermediate. The kinetic, the secondary, and the intramolecular isotope effects in the conversion of (1-^{3}H)tetralin to 1,2-dihydro(4-^{3}H)naphthalene and of 1,2-dihydro(1-^{3}H)naphthalene to (1-^{3}H)naphthalene were determined. The isotope effects involved in both conversions were of the same order of magnitude, the intramolecular effect being 10 and 23, the kinetic effect 2.1 and 2.4, and the secondary effect 0.9 and 0.8 in the first and second conversion, respectively. These data indicate the α-hydrogen abstraction as the rate determining step in accordance with the proposed hydride transfer mechanism. (auth) (UK)

51463 DIELECTRIC CONSTANT MEASUREMENT OF HYDROGEN ISOTOPES IN THE LIQUID PHASE. **Kogan, V. S.; Milenko, Yu. Ya.; Grigorova, T. K. (Physical-Technical Inst., Kharkov). Physica; 53: No. 1, 125-31(17 May 1971).**

The dielectric constants of liquid normal hydrogen, normal deuterium, and hydrogen deuteride were measured by a resonance method for frequencies of about 10^{10} Hz on the liquid–vapor equilibrium curve from the triple points to 20.4°K. By means of the Clausius–Mossotti equation the polarizabilities of the hydrogen isotopes have been compared. The following results were obtained: $\Delta\alpha_{H_2\text{-}HD}/\alpha_{n\text{-}H_2} = 0.65\%$; $\Delta\alpha_{H_2\text{-}nD_2}/\alpha_{n\text{-}H_2} = 1.35\%$. (auth)

51464 PERMEATION OF ELECTROLYTICALLY GENERATED HYDROGEN AND TRITIUM ATOMS THROUGH LEAD. **Muju, B. L.; Smith, F. R. (Memorial Univ., St. John's, Newfoundland). Can. J. Chem.; 49: 2406-11(15 Jul 1971).**

Radiochemical and electrochemical evidence is presented that electrochemically generated tritium and hydrogen atoms permeate through lead foil at measureable rates at room temperature. The permeation process is controlled by diffusion through the metal lattice, Fick's First Law being obeyed by both H and ^{3}H atoms. Using earlier measurements of the diffusivity of H in Pb, H, and ^{3}H concentrations of 4×10^{-7} and 9×10^{-13} g-atom cm^{-3} are computed for a current density of 53 mA cm^{-2} at the Pb cathode surface. The overall hydrogen–tritium separation factor, S_T, is apparently 0.3 ± 0.15, in contrast to Bockris and Srinivasan's 6.7 and 7.2 for cathodic gas evolution from acidic and alkaline media, respectively. Reasons are suggested for this large difference. (auth) (Canada)

Physical Chemistry

Refer also to abstracts 52098, 52352, 52353, 54099, 54100, and 54284.

51465 (A/CONF.49/P–546) DRY SEPARATION OF VOLATILE FLUORIDES OF URANIUM AND OTHER HEAVY ELEMENTS. **Peka, I.; Rak, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). May 1971. 19p. (CONF-710901-238). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses o atomic energy; Geneva, Switzerland (6 Sep 1971).

Some physicochemical properties of systems of volatile fluoride–perfluoroorganic solvent and volatile fluoride–solid sorbent are described with regard to mutual separation of mixtures of volatile fluorides by ultracentrifugation and sorption. The physicochemical properties of perfluoroorganic liquid solutions of volatile metallic fluorides released during fluorination of an irradiated fuel element were measured. Owing to the ideal behavior of dissolved hexafluorides of heavy metals, the possibility of their mutual separation by ultracentrifugation was studied. Solutions of mixtures of fluorides having various molecular weights were centrifuged. The conditions of the sorption of volatile fluorides on solid fluorides from a gaseous phase and from a perfluoroorganic solvent medium were compared. (auth)

51466 (CONF-711001–(Vol.1), pp 74-83) CRYSTAL CHEMISTRY OF THE SALT-LIKE RARE-EARTH DIHALIDES AND THE DETERMINATION OF THE NEW STRUCTURE TYPE Ln_3O_4Br. **Baernighausen, H.; Beck, H. P.; Grueninger, H.-W. (Karlsruhe Univ. (West Germany). Institut fuer Anorganische Chemie). 1971.**

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The salt-like rare-earth dihalides (17 compounds known at present omitting the recently discovered DyI_2) belong to seven structure types, namely CaF_2 [SmF_2, EuF_2, YbF_2], $PbCl_2$ [$NdCl_2$, $SmCl_2$, $EuCl_2$, EuF_2 (high-pressure form)], $SrBr_2$ [NdI_2, $SmBr_2$, $EuBr_2$], SrI_2 [EuI_2 (orthorhombic), $DyCl_2$, $TmCl_2$, $YbCl_2$], EuI_2 (monoclinic) [SmI_1], $CaCl_2$ [$YbBr_2$], and CdI_2 [TmI_2, YbI_2]. For most of these compounds, the given assignment is based on the interpretation of x-ray diffraction powder photographs, but for $EuCl_2$, $EuBr_2$, EuI_2, $YbCl_2$, and $YbBr_2$ the results of single-crystal studies are available. The crystal structures of the just mentioned europium dihalides were examined in detail using three-dimensional x-ray data (MoK_α radiation). In order to complete the work on the compounds Ln_3O_4Br (Ln = Nd, Sm, Eu, Yb) a single-crystal study was undertaken for Eu_3O_4Br by usual x-ray diffraction methods. As expected from the general point of view for rare earth oxysalts given by Caro (1968), the main structural feature of the Eu_3O_4Br crystal structure is the polymeric complex cation $(EuO)_n^{n+}$. The arrangement of atoms in this cation is closely related to the one found in the $(EuO)_n^{n+}$ layer of the EuOBr crystal structure. (auth)

51467 (CONF-711001–(Vol.1), pp 84-95) GROWTH AND X-RAY STUDIES OF SINGLE CRYSTALS OF HIGHER OXIDES OF PRASEODYMIUM AND TERBIUM. **Lowenstein, M. Z.; Kihlborg, L.; Lau, K. H.; Haschke, J. M.; Eyring, L. (Arizona State Univ., Tempe. Dept. of Chemistry). 1971.**

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Single crystals of higher oxides of praseodymium and terbium were successfully grown using hydrothermal techniques. Cold seal reactors were utilized to study the crystallization process over a temperature range of 600 to 900°C and at pressures up to 3.1×10^3 atm. Crystal growth conditions were optimized using controlled pressure and temperature cycling. Any oxide of praseodymium may be used as starting material. Nitric acid served both as a mineralizer to promote solubility and as a source of oxygen. Two predominant crystal habits are observed: octahedra and trigonal prisms. Faces are smooth and well defined. Single crystals of praseodymium dioxide were reduced to $PrO_{1.833}$ in the homologous series Pr_nO_{2n-2} with crystal integrity maintained. X-ray data were obtained on these crystals using Weissenberg and Hägg–Guinier cameras. The phase has a fluorite-type sublattice with a superstructure of monoclinic symmetry (space group $P2_1/n$, C_{2h}^5) and a unit cell having a = 6.681 Å, b = 11.59 Å, c = 15.48 Å, β = 125.2°, and V = 979.6 Å^3. The relationship to the fluorite subcell is shown. (auth)

51468 (CONF-711001–(Vol.1), pp 322-9) BASICITIES OF TRIVALENT ACTINIDES AND LANTHANIDES AND SOLUBILITIES OF THEIR HYDROXIDES. **Weaver, Boyd; Shoun, R. R. (Oak Ridge National Lab., Tenn.). 1971.**

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Lanthanides and Am and Cm (0.002 M solutions) were titrated with 0.050 N NaOH, and graphs of pH vs volume of OH^- addition are presented. The possible correlation of pH with ionic radius is examined, and the data are compared with those of Moeller and Kremers (J. Phys. Chem., 48: 395(1944)). The stoichiometry of the hydroxide precipitation is considered; Cm is precipitated almost entirely as $Cm(OH)_2NO_3$. Solubilities and solubility products are calculated on the basis of observed stoichiometries and compared with those of Moeller and Kremers. (D.L.C.)

51469 (CONF-711001–(Vol.1), pp 330-42) LANTHANIDE OXALATES AND SOME OF THEIR DERIVATIVES. **Weigel, F.; Ollendorff, W.; Merz, R.; Mulokozi, A. M. (Munich Univ. (West Germany). Institut fuer Anorganische Chemie). 1971.**

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The nature of the precipitate formed by addition of oxalic acid, alkali oxalates, or ammonium oxalate to a solution of a trivalent lanthanide depends on the position of the lanthanide within the series, the pH of the solution, and the anions present. Five different types of compounds were identified by x-ray diffraction and chemical analysis: I. $Ln_2(C_2O_4)_3 \cdot 10H_2O$ (Ln = La . . . Er);

XUM

II. $HLn(C_2O_4)_2 \cdot 3 \ldots 4H_2O$ (Ln = Tb . . . Lu); III. $LnC_2O_4Cl \cdot 3H_2O$ (Ln = La . . . Gd); IV. $LnC_2O_4Br \cdot 3 \ldots 7H_2O$ (Ln = La . . . Gd); and V. $Ln_2(C_2O_4)_2(SO_4) \cdot 8H_2O$ (Ln = Tb . . . Lu). Detailed studies are reported for I, III, and IV. (auth)

51470 (CONF-711001-(Vol.2), pp 573-83) SOLUBILITY OF $Er(OH)_3$ UNDER HYDROTHERMAL CONDITIONS. Mroczkowski, S.; Eckert, J. (Yale Univ., New Haven, Conn.). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The phase transition from $Er(OH)_3$ to ErOOH as a function of NaOH concentration was determined. The solubility of $Er(OH)_3$ in NaOH solutions was determined and plotted as functions of temperature and NaOH concentration. No decrease in solubility due to complex formation was found, and it was concluded that, for growth of large $Er(OH)_3$ single crystals, a temperature should be chosen such that ErOOH crystallizes at the bottom of the vessel, with a large enough gradient for $Er(OH)_3$ to crystallize near the top. (D.L.C.)

51471 (CONF-711001-(Vol.2), pp 584-96) VAPORIZATION THERMODYNAMICS OF EUROPIUM(II) CHLORIDE AND EUROPIUM(III) OXIDECHLORIDE. Hariharan, A. V.; Eick, Harry A. (Michigan State Univ., East Lansing. Dept. of Chemistry). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The vapor pressure of liquid $EuCl_2$ was measured in the temperature range 1135 to 1569°K by a target collection Knudsen effusion technique. At the median temperature of 1352°K, the enthalpy and entropy of vaporization to the gaseous dichloride are: 70.39 ± 0.30 kcal gfw^{-1} and 31.62 ± 0.22 eu, respectively. The second law data were reduced to 298°K with estimated heat capacity changes to give $\Delta H^0_{s298} = 84.90 \pm 1.70$ kcal gfw^{-1} and $\Delta S^0_{s298} = 48.3 \pm 1.5$ eu. The estimated boiling point of the dichloride is 2335 ± 35°K, with $\Delta H^0_V = 58.9 \pm 1.9$ kcal gfw^{-1} and $\Delta S^0_V = 25.23 \pm 0.68$ eu. The incongruent vaporization behavior of EuOCl was also examined over the temperature range 1236 to 1617°K. For the incongruent vaporization to the gaseous dichloride and chlorine gas, the equilibrium constant is given by the equation: $\ln K = -(63735 \pm 321)\ T + 28.80 \pm 0.23$. The enthalpy of formation of EuOCl(s) is found to be −213.9 ± 3.3. The dichloride and oxidechloride vaporization behavior is discussed. (auth)

51472 (UCRL-20580) ^{17}O NUCLEAR MAGNETIC RESONANCE STUDIES OF THE FIRST HYDRATION SPHERE OF DIAMAGNETIC METAL IONS IN AQUEOUS SOLUTION. Neely, James Watson (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1971. Contract W-7405-eng-48. 72p. Dep. NTIS.

Thesis.

The rate of water exchange between hydrated cations and solvent was measured by observation of the oxygen-17 NMR signal of the waters in the first coordination sphere. Interference from the bulk water resonance was avoided by the addition of sufficient Mn^{2+} to broaden the bulk water signal at least ten times as broad as the bound water signal. Values for the rate constants at 25°C and the enthalpy and entropy of activation were measured for Mg^{2+}, Ga^{3+}, Be^{2+}, Th^{4+}, and In^{3+}. No bound water resonance could be observed using the present technique for solutions containing UO_2^{2+}, Tl^{3+}, Sc^{3+} and Zn^{2+}. For these ions only lower limits could be set for the rate of water exchange. (auth)

51473 OBSERVATION AND INTERPRETATION OF LOW ENERGY BANDS IN THE SOLUTION ABSORPTION SPECTRA OF Bk^{3+} AND Bk^{4+}. Carnall, W. T.; Sjobbom, R. K.; Barnes, R. F.; Fields, P. R. (Argonne National Lab., Ill.). Inorg. Nucl. Chem. Lett.; 7: No. 7, 651-7(Jul 1971).

Reference is first made to earlier studies on the solution absorption spectra of Bk (J. Inorg. Nucl. Chem., 29: 2341(1967)), followed by the results of recent experiments with much larger amounts of Bk than were earlier available, in which the absorption spectra of solutions of Bk^{3+} and Bk^{4+} in deuterated solvents were reexamined in the visible and near infrared. The absorption characteristics of Bk^{3+} previously reported were verified and more clearly delineated, and a single isolated absorption band characteristic of Bk^{4+} was observed, centered at ~0.63 μ. Some of the implications of these results in terms of energy level parameters for the 3+ and 4+ actinides are discussed. Experimental details are given. The results and interpretation of the spectra are considered to be consistent with a more general reevaluation of the relative magnitudes of electrostatic and magnetic interactions in actinide ions. (UK)

51474 ELECTRODE REACTIONS OF SOME RARE EARTH ELEMENTS AT THE MERCURY DROPPING ELECTRODE. Novakovskaya, E. G.; Nadezhina, L. S. (Leningrad Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 14: No. 4, 523-7(1971). (In Russian).

For electrode processes involving La, Ce, Nd, and Eu, reaction rates and current densities were measured by three polarographic techniques: classical, oscillographic, and alternating current, using 0.1N LiCl as the background solution in all experiments. Gokhshtein's equation was employed to calculate formal rate constants, which in turn were used to compute the following rate constants at equilibrium potential: $La^{3+} = 3.2 \times 10^{-3}$, $Ce^{3+} = 2 \times 10^{-3}$, $Nd^{3+} = 1 \times 10^{-3}$, and $Eu^{3+} = 2.5 \times 10^{-3}$ cm/sec. (K.S.W.)

51475 LATTICE DYNAMICS OF DICESIUM URANIUM HEXABROMIDE. Chodos, Steven Leslie. Los Angeles; Univ. of California (1971). 122p. University Microfilms Order No. 71-21,320.

Thesis.

A lattice dynamical model for Cs_2UBr_6 is presented. The model consists of a valence force field to describe the short-range interactions of the UBr_6^{-2} complex, and also long-range Coulomb forces to describe the ionic character of the crystal. The model has a minimal number of parameters (seven) which are evaluated by fitting the single phonon energies obtained optically. The phonon dispersion curves and density of states are presented. The electron-phonon interaction, which gives rise to the vibronic spectra accompanying the $5f^2-5f^2$, U^{+4} intraconfiguration transitions, is discussed in some detail. It is found that transitions from the ground state to excited states are possible if they are coupled to lattice vibrations of the proper symmetry. It is further found that the intensity of these transitions reflects the density of states of these lattice vibrations. The intensity of these vibronic sidebands is calculated using the phonons of the model discussed above. The agreement with the experimental sidebands is excellent. (Diss. Abstr. Int., B)

51476 AMALGAM POLAROGRAPHY OF LANTHANUM. Sagadieva, K. Zh.; Esimbekova, B. B. (Kazakh State Univ., Alma-Ata, USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 14: No. 4, 482-4(1971). (In Russian).

The anode behavior of La amalgan in various solutions was studied by the polarographic method. The half-wave potential of La oxidation and angular coefficient was measured with 0.1M reference solutions of KCl, LiCl, KNO_3, K_2SO_4, and NaOAc + Trilon B. The wave height was proportional to the La content in the amalgam. The diffusion coefficient of La atoms in Hg was calculated to be 1.06×10^{-5} cm^2/sec. The irreversibility of the electrode reaction $La(Hg)/La^{3+}$ was established and the velocity constant for this process was determined. (K.S.W.)

51477 PHASE DIAGRAMS OF THE SYSTEMS $PbCl_2-UCl_4$ AND $PbCl_2-UCl_3$. Borowitz, J. L.; Rafaeloff, R.; Roy, A. (Soreq Nuclear Research Centre, Yavne, Israel). J. Electrochem. Soc.; 118: No. 8, 1358-61(Aug 1971).

The phase diagrams of the salt mixtures UCl_4-PbCl_2 and UCl_3-PbCl_2 were investigated by means of thermal analysis. There is a single eutectic at 50 mole per cent (m/o) UCl_4 and 346°C in the UCl_4-PbCl_2 system. A compound with incongruent melting point, of a composition $6PbCl_2:1UCl_4$ decomposing at 386°C is apparent. The melting points of the pure salts, as measured, are 503°C for $PbCl_2$, 590°C for UCl_4. The UCl_3-PbCl_2 system has a single eutectic at 11 m/o UCl_3 and 470°C, with no peritectic reaction. A heat effect at 342°C was noted. The melting points of the pure salts as measured are for $PbCl_2$ 502°C for UCl_3 841°C. X-ray diffraction analyses gave no indication of solid solution in either system. Analysis of both the phase diagrams according to the Van't Hoff equation indicates that both systems behave like ideal mixtures [in accordance with Temkin's (1) model] oversignificant concentration ranges. (auth)

51478 TEMPERATURE QUENCHING OF LUMINESCENCE OF ORGANIC SOLUTIONS OF URANYL COMPOUNDS. Volod'ko, L. V.; Turetskaya, E. A. Zh. Prikl. Spektrosk.; 11: No. 2, 294-8(Aug 1969). (In Russian).

A method is described for determining the relative quantum yield of two centers of luminescence existing simultaneously in solution. The relationship between quantum yield and the temperature was investigated for solutions of uranyl nitrate in propanol and butanol as well as for uranyl acetate in butanol. (D.H.M.)

Radiation and Nuclear Chemistry

Refer also to abstracts 51543, 51584, 51794, and 51795.

51479 (A/CONF.49/P-827) INDUSTRIAL APPLICATIONS OF RADIATION AND RADIOISOTOPES IN JAPAN. Motojima, K.; Danno, A.; Kobayashi, M. (Japan Atomic Energy Research Inst., Tokyo); Hirayama, T.; (and others) May 1971. 28p. (CONF-710901-347). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Recent developments and correlated research on radiation and radioisotopes in industries and research institutions in Japan are described. Various pilot-scale experiments and applied research on radiation chemistry are being conducted at the Takasaki Research Establishment. These include the radioinduced polymerization of ethylene in the gas phase, polymerization of trioxane and tetraoxane in the solid state, polymerization of acrylonitrile at low temperature, copolymerization of tetrafluoroethylene and propylene, radioinduced grafting of butadiene onto poly(vinyl chloride) powder, grafting of styrene onto cellulose fibers, grafting of acrylonitrile onto poly(vinyl chloride)fibers, electron curing of coating and fiber-reinforced plastics, and modification of polyolefins by cross-linking. At present, private enterprises are endeavoring to industrialize a number of radiation processes. Cross-linked plastic materials and foamed polyethylene sheets are being produced by several companies. Production of wood–plastic combinations and radiation curing of coatings are being developed in Japan. Low-energy electron accelerators with high current are also produced in Japan for radiation curing. Among the several fields of industrial applications of radioisotopes, recent works are introduced as examples showing modern trends. These are: "on-off" switching control of petroleum pipelines using ^{60}Co sealed sources, production of ^{170}Tm and ^{192}Ir sources and their applications to the nondestructive testing of jet aircraft, construction of radioisotope power generators, the production of strontium titanate ceramic, control of Bessemer converter operation by using 14-MeV neutron generator, tracer experiments in aluminum refinement, and experiments of pesticide spray using activable tracer. (auth)

51480 (UJV–2611-Ch) CORRELATION BETWEEN RADIATION–CHEMICAL, OPTICAL, AND OTHER DYNAMIC PROPERTIES OF ORGANIC MOLECULES. Santar, Ivan (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1971. 24p. (CONF-710517–4). Dep. NTIS (U. S. Sales Only).

From third symposium on radiation chemistry; Tihany, Hungary (10 May 1971).

A preliminary survey is given of existing experimental evidence on molecular ionization cross sections and W-values on one side, and on optical spectra and electron polarizability on the other side, to support the view that close relationships tie together these dynamic properties. It is shown that information of considerable interest to radiation chemistry can be gained when these relationships are put on a systematic basis serving as a background for the evaluation of experimental data. The results are illustrated by treating in more detail a few representative groups of organic substances. (auth)

51481 ELECTRON ATTACHMENT AND NEGATIVE ION-MOLECULE REACTIONS IN PURE OXYGEN. Parkes, David A. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Faraday Soc.; 67: No. 579, 711-29(Mar 1971).

The formation of negative ions in oxygen by electron attachment and by subsequent ion-molecule reactions was studied in the gas phase, using a drift-tube and mass filter. Pressures ranged between 0.65 and 13 mbar (0.5–10 torr) and reduced fields (field/density) between 3×10^{-18} and 6×10^{-16} V cm^2 part.$^{-1}$. At reduced fields between 10^{-16} V cm^2 part.$^{-1}$ masses 32 (O_2^-), 64 (O_4^-) and 50 ($O_2 \cdot H_2O^-$) predominated. The O_2^- formed initially was converted to O_4^- in a three-body reaction, $O_2^- + 2O_2 \rightleftharpoons O_4^- + O_2$, with a thermal rate constant of $3 \pm 0.5 \times 10^{-31}$ part.$^{-2}$ ml^2 s^{-1} at 298°K. The back reaction had a rate constant of $7 \pm 1 \times 10^{-15}$ part.$^{-1}$ ml s^{-1}. The hydrate concentration was related to that of the dimer via the reactions, $O_4^- + H_2O \rightleftharpoons O_2 \cdot H_2O^- + O_2$. The forward rate constant was estimated to be of the order of 10^{-9} part.$^{-1}$ ml s^{-1}, and the back was measured as $2.5 \pm 1 \times 10^{-15}$ part.$^{-1}$ ml s^{-1}. At higher fields the initially formed mass 16 (O^-) was converted irreversibly to mass 48 (O_3^-): $O^- + 2O_2 \rightarrow O_3^- + O_2$. The thermal rate constant was measured as $1.05 \pm 0.1 \times 10^{-30}$ part.$^{-2}$ ml s^{-1} up to pressures of at least 13 mbar, without any significant change in order. The change in the rate constants with ion collisional energy was also followed. (auth) (UK)

51482 RADIATION CHEMISTRY OF OCTAMETHYLTRISILOXANE. Tanny, G. B.; St. Pierre, L. E. (McGill Univ., Montreal). J. Phys. Chem.; 75: No. 16, 2430-5(5 Aug 1971).

The radiation chemistry of octamethyltrisiloxane was studied in an attempt to define the nature of the scissioning reaction in polydimethylsiloxane. Three linear products, hexamethyldisiloxane, decamethyltetrasiloxane, and dodecamethylheptasiloxane were produced in high yields. The cyclic product, octamethylcyclotetrasiloxane, was also present in appreciable quantities. On the basis of the dimer yields, the G crosslinking was found to be 2.85. (auth)

51483 CONVERSIONS OF 1,4-ETHENE-1,4,5,6,9,10-HEXAHYDRONAPHTHALENE UNDER ACTION OF THE γ-RADIATION OF ^{60}Co. Naumova, S. F.; Tsykalo, L. G.; Zaslavskii, Yu. S.; Erofeev, B. V. (Inst. of Physicoorganic Chemistry, Minsk). High Energy Chem. (USSR) (Engl. Transl.); 4: No. 5, 404-5(Sep-Oct 1970).

Translated from Khim. Vys. Energ.; 4: No. 5, 453(Sep–Oct 1970).

The conversion of 1,4-ethene-1,4,5,6,9,10-hexahydronaphthalene (a dimer of 1,3-cyclohexadiene) under the action of the γ-radiation of ^{60}Co was studied within the dose range 1 to 20×10^6 rad. The following conversions occur under these conditions: radiolysis with the formation of gaseous and liquid readily-volatile products, polymerization, isomerization, and depolymerization. The gaseous products include hydrogen, ethylene, and acetylene. The liquid products include cyclohexane, cyclohexene, and benzene. Individual oligomeric products with a degree of polymerization n = 2,3,4, and higher were isolated by the chromatographic method; their physicochemical characteristics were determined. The shape of the molecular weight distribution curves of the oligomeric products shows that at high irradiation doses, the distribution approaches equilibrium. (auth)

Radiation Effects

Refer also to abstracts 51993, 51994, and 52931.

51484 CALORIMETRIC EVIDENCE OF MOLECULAR HYDROGEN IN IRRADIATED LITHIUM HYDRIDE. Catalano, E.; Leider, H. R. (Univ. of California, Livermore). J. Phys. Chem. Solids; 32: No. 6, 1297-1301(Jun 1971).

A calorimetric measurement employing the thermal arrest technique independently confirmed the presence of molecular hydrogen in irradiated LiH previously detected by pulsed nuclear magnetic resonance (NMR). The melting endotherm of the hydrogen indicates adsorption of hydrogen on the surfaces of the bubbles containing the hydrogen. (auth) (UK)

51485 INFLUENCE OF GAMMA-RADIATION ON THE PROPERTIES OF FURAN CATIONIC EXCHANGE RESINS. Mansurov, P. Kh.; Abrarov, O. A.; Ibragimov, Kh. P. (Tashkent Polytechnic Inst.). Dokl. Akad. Nauk Uzb. SSR; No. 11, 35-6(1970). (In Russian).

It is thought that the processes of break-down and crosslinking of the macromolecule both contribute to the change in the properties of an ion exchange resin under the influence of radiation. This concept was developed further by subjecting samples of a sulfofuran cationic exchange resin to radiation from a ^{60}Co source in doses from 5×10^4 to 10^8 R, and then determining the specific volume, ion exchange capacity, solubility, swelling power, etc. Increased doses of radiation lowered the ion exchange capacity, increased the specific volume, and increased the "acidity" of the resin as measured by titrating a leached sample. (K.S.W.)

51486 UNSTABLE INTERMEDIATES. PART XCIV. HYPERFINE COUPLING AND ZERO-FIELD SPLITTING FOR NITROGEN ATOMS IN γ-IRRADIATED AZIDES. Begum, A.; Symons, M.C.R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 12, 2062-5(1971)

Exposure of sodium azide to ^{60}Co γ rays at 77°K gave an ESR spectrum dominated by hyperfine components previously assigned to F-centres. On careful annealing these centres are destroyed, revealing features characteristic of trapped nitrogen atoms. At 77°K, A(^{14}N) = 5.7 G, D = 64 G and E = (–) 8 G, but on warming to about 160°K the spectrum changed reversibly to give D = 37 G and E = 0. All parameters decreased slightly on warming the samples. Similar results were obtained for potassium azide except that no F-centres were detected. The results are discussed in terms of slight admixtures of the nitrogen 2s orbital into the ^{4}S ground-state of the atoms. (auth) (UK)

51487 THERMAL DECAY EFFECTS ON SPATIAL DISTRIBUTIONS OF RADICALS IN γ-IRRADIATED POLY(METHYL METHACRYLATE). Kaul, Walter (Physikalisch-Technische Bundesanstalt, Brunswick); Kevan, Larry. J. Phys. Chem.; 75: No. 16, 2443-8(5 Aug 1971).

Spin–spin, T_2, and spin–lattice, T_1, relaxation times were measured for the radicals in γ-irradiated PMMA at room temperature vs. radiation dose and vs. thermal decay time after irradiation. T_2 is related to the local spin concentration around a radical. The local spin concentrations are larger than the average spin concentrations over the entire sample up to doses of about 5 Mrads. This indicates that the radicals are trapped in regions of high local spin concentration called spurs. At doses above 7 Mrads the local and average spin concentrations are comparable. During thermal decay at doses less than 5 Mrads the local spin concentration decreases fractionally faster than the average spin concentration which indicates intraspur decay. During thermal decay at doses greater than 7 Mrads the local and average spin concentrations decrease at similar fractional rates. (auth)

51488 THERMAL AND RADIATION EFFECTS ON ^{51}Cr(III)-DOPED CRYSTALLINE OXY-SALTS. **Khorana, S.; Wiles, D. R. (Carleton Univ., Ottawa). J. Inorg. Nucl. Chem.; 33: No. 6, 1589-95(Jun 1971).**

The conversion of Cr^{3+} to CrO_4^{2-} by heat and by radiation was studied using $^{51}Cr^{3+}$-doped samples of KNO_3, KIO_3, and K_2SO_4. Thermal conversion occurs on KNO_3 and KIO_3, but not on K_2SO_4. Radioinduced conversion was found to be a function of intensity and irradiation temperature. Uv light was found to be effective for KNO_3 and KIO_3, but in K_2SO_4 uv causes conversion only at short wavelengths (~1850 Å). Gamma radiation is effective in all cases. These results, as well as those from Szilard-Chalmers and transfer annealing studies, are interpreted in terms of an electron-hole model in which the electron promotion energy is a critical parameter. It is speculated that species such as SO_4^- are involved. (auth) (UK)

51489 ESR OBSERVATION OF METHYL RADICAL-HALIDE ION PAIRS PRODUCED BY DISSOCIATIVE ELECTRON CAPTURE IN A CRYSTALLINE MATRIX. **Sprague, Estel D.; Williams, Ffrancon (Univ. of Tennessee, Knoxville). Contract AT(40-1)-2968. J. Chem. Phys.; 54: No. 12, 5425-7(15 Jun 1971). (ORO-2968-62).**

Information on the interaction of methyl radicals and halide ions was obtained from ESR studies of γ-irradiated bromomethane and chloromethane in CD_3CN crystals. The ESR spectrum changed dramatically on warming the sample suddenly to 175°K for a few seconds. This brief thermal annealing brings about the irreversible dissociation of methyl radical—bromide ion pairs. (D.H.M.)

51490 ELECTRON SPIN RESONANCE STUDIES OF FREE RADICALS IN IRRADIATED SINGLE CRYSTALS OF 5-METHYLCYTOSINE. **Huettermann, Juergen; Ward, John F.; Myers, L. S. Jr. (Univ. of California, Los Angeles). Contract AT(04-1)-GEN-12. Int. J. Radiat. Phys. Chem.; 3: No. 2, 117-29(Aug 1971).**

Exposure of single crystals of 5-methylcytosine to ionizing radiation gives rise to electron spin resonance (ESR) spectra, which at room temperature can be explained as resulting predominantly from two chemically distinct stable free radicals produced in the crystals. One is formed by addition of a hydrogen atom to the 6-position of the pyrimidine ring. Its essentially isotropic hyperfine spectrum is generated by interaction of the unpaired electron in a 2p-orbital of carbon atom $C_{(5)}$ with three equivalent protons of the 5-methyl group and two non-equivalent protons attached to carbon $C_{(6)}$, all protons being in the β-position. The second radical results from removal of a hydrogen atom from the 5-methyl group. The unpaired electron of this radical is localized mainly in 2p-orbitals of the methyl carbon and of ring carbon $C_{(6)}$ giving rise to a hyperfine spectrum from interaction with the two remaining α-protons of the methyl group and the α-proton attached to $C_{(6)}$. All couplings are anisotropic with principal values of $A_x = 24.9$, $A_y = 16.3$ and $A_z = 8.6$ gauss for the methyl protons and $B_u = 12.5$, $B_v = 8.6$ and $B_w = 2.1$ gauss for the $C_{(6)}$-proton. Measurements at low temperatures reveal the presence of a third type of radical featuring a doublet ESR resonance which is tentatively assigned to the radical anion of 5-methylcytosine. These findings are discussed in connection with results reported for related compounds. (auth)

51491 FLUORESCENCE OF AQUEOUS SODIUM SALICYLATE. SOLUTIONS UNDER EXCITATION BY IONIZING RADIATIONS. **Stein, Gabriel; Tomkiewicz, Micha (Hebrew Univ., Jerusalem). Trans. Faraday Soc.; 67: 1678-89(Jun 1971).**

The equations derived in the expanding sphere model (Stein and Tomkiewicz 1971) were applied to experimental results on the fluorescence from aqueous salicylate solutions under x irradiation. The results fit the theory well over a wide concentration range and their deviation from the behavior of the same system under uv irradiation agrees quantitatively with a mechanism involving the nonhomogeneous quenching by radioinduced radicals of solute molecules excited by the same ionizing radiations. (auth) (UK)

51492 CHEMISTRY OF ALIPHATIC UNCONJUGATED NITRAMINES. PART 5. PRIMARY PHOTOCHEMICAL PROCESSES IN POLYCRYSTALLINE RDX. **Stals, J.; Buchanan, A. S.; Barraclough, C. G. (Univ. of Melbourne). Trans. Faraday Soc.; 67: 1749-55(Jun 1971).**

The CPR spectra of polycrystalline RDX, and its single crystals, when irradiated with γ radiation and 254 nm light at 77 to 298K, indicate that $\cdot NO_2$ may be a primary photochemical product of RDX. Mass spectral analyses of the gaseous products suggested that N_2 and NO may also be primary photolysis products of RDX. The identity of these products was consistent with the theoretically predicted bond cleavage patterns of the axial and equatorial nitramine groups of RDX and HMX. A combination of theory and experiment thus permitted the tentative assignment of the primary photochemical steps for polycrystalline RDX. (auth) (UK)

Radiation Processes

Refer also to abstract 52290.

51493 (A/CONF.49/P-466) LARGE-SCALE RADIATION-CHEMICAL PLANTS AND RADIATION-CHEMICAL PROCESSES OF PROMISE FOR COMMERCIAL APPLICATION. **Bayer, A. A.; Vereshchinskii, I. V.; Dzhagatspanyan, R. B.; Karpov, V. L.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 37p. (CONF-710901-392). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Data are presented on radiation chemical processes that have been or will be introduced into industry within the next few years, and demonstration plants are described. Plants for the irradiation of both liquids and solids are considered. Ionizing radiation is used for initiating chemical reactions in the sulfochlorination of n-paraffins as a means of producing biodegradable emulsifiers and detergents. A comprehensive description is given of a radiation sulfochlorinator. The synthesis of tetrachloroalkanes comprises a hard-to-control catalytic process. Radiation used to initiate this process makes possible its easy control and the production of purer products. The process kinetics, flow sheet and structural assemblies of a demonstration plant are included. Radiation cross-linking of polymer materials is used for production of compounds with specific properties. Radiation modification of cable insulators by a powerful electron beam and radioinduced vulcanization of rubbers are used as examples of such processes. (auth)

51494 (A/CONF.49/P-829) RADIATION POLYMERIZATION ON NATURAL PRODUCTS IN PAKISTAN. **Ahmad, Aminuddin; Husain, Ather (Pakistan Inst. of Nuclear Science and Tech., Rawalpindi); Rashid, Abdur; Farhataziz (Atomic Energy Centre, Lahore (Pakistan)). Jun 1971. 12p. (CONF-710901-364). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Studies on the radioinduced graft polymerization of various monomers like styrene, methyl methacrylate, and acrylonitrile on wood, cellulose, jute, and agricultural wastes like wheat straw and rice husk, and stone waste are reviewed. Grafted samples of cheap varieties of pinewood (Pinus roxburghii) and gurjan (Dipterocarpus turbinatus) showed enhanced resistance to microorganism (Aspergillus niger 67) and to corrosion and bacterial effects of soil, in addition to increased water repellancy and dimensional stability. Gamma irradiation effects were studied on cellulose in various media, water, hydrogen peroxide, hydrochloric acid, chlorine water, and carbon tetrachloride. Degradation of molecular weight was measured by Oswald's viscometer with and without oxygen, and G-breakages were determined. Copper number and carboxyl group were also determined in each of these media. Methyl methacrylate, styrene, and acrylonitrile were copolymerized on jute. The jute—polymer composite (JPC) showed increased water repellancy and resistance to microorganism (Aspergillus niger 67). Nevertheless, it was observed that the breaking strength of JPC is reduced. Ethyl acrylate when grafted on jute imparts a promising increase in abrasion resistance. A process called Farra technique has been developed for binding agricultural and stone wastes by in situ homopolymerization of monomers on these materials under irradiation. Agricultural wastes have been transformed into strong materials that can find use as wood substitutes or supplements. Stone wastes have been converted into well set products that have a potential as decorative building materials. The products can be obtained in single or multiple colors. The outstanding feature of the process is that it employs raw materials that are readily available in abundance in developing countries. (auth)

51495 (COO-1116-19) EXCHANGE MECHANISM AND ARRHENIUS PARAMETERS OF ELEMENTARY STEPS IN THE REACTIONS OF HYDROGEN ATOMS WITH WATER VAPOR IN IRRADIATED MIXTURES OF HYDROGEN AND WATER VAPOR. **Bibler, N. E.; Firestone, R. F. (Ohio State Univ., Columbus. Dept. of Chemistry). [1971]. Contract AT(11-1)-1116. 37p. Dep. NTIS.**

Efficiencies of the radioinduced exchange reactions, $H_2 + D_2O = HD + HOD$ and $H_2 + D_2O = D_2 + H_2O$, were measured at 84 to 381°C.

XUM

G(HD) is equal to 13.1 ± 0.3 molec./100 eV and is independent of temperature, under conditions employed, in the range 114 to 150°C. At higher temperatures HD is formed by a chain reaction propagated by $H + D_2O \rightarrow HD + OD$ and $H + D_2O \rightarrow HOD + D$ at comparable rates, and D_2 is formed by $H + D_2O \rightarrow D_2 + OH$ at a much slower rate at 218 to 381°C. Activation energies and relative frequency factors for these elementary steps and for $D + D_2O \rightarrow D_2 + OD$ were evaluated. (auth)

51496 POLYOXYMETHYLENE PREPARED BY γ-RAY-INDUCED POLYMERIZATION OF TETRAOXYMETHYLENE SINGLE CRYSTAL. Tanaka, A.; Uemura, S.; Ishida, Y. (Osaka Univ.). Kolloid-Z. Z. Polym.; 243: No. 1, 3-6(Jan 1971).

In order to prepare a large single crystal, tetraoxymethylene recrystallized by distilled water adjusted to pH 8 was sealed in an ampoule at a reduced pressure of 1 mm Hg and was crystallized in a furnace with the temperature gradient of 6°C/cm. The lowering rate of the ampoule was required to be 6 cm/day for preparing the single crystal with 1 cm diameter and to be 3 cm/day for one with 2 cm diameter. The optimum angle at the pointing end of the ampoule, where a seed crystal is formed, was about 40°. The b-axis of the obtained single crystal was parallel to the direction of the crystal growth i.e. the wall of the ampoule. It was polymerized by γ-ray under conditions that prevented the growth of the twin crystal. The polyoxymethylene obtained was porous, because the polymerization yield of 100% could not be attained. However, it was so tough that a specimen for measurements could be cut down by a diamond cutter. Its fiber axis was parallel to the direction of the wall of the ampoule. It did not contain the so-called amorphous regions, although it did contain defects. It was characterized with the extremely high orientation of the polymer chains. (auth)

51497 HIGHLY RADIATION-SENSITIVE TELOMERISED POLYESTERS. D'Alelio, Gaectano Francis (to PPG Industries Inc.). British Patent 1,235,769. 16 Jun 1971. Filed 20 Mar 1969.

Reference is made, in particular, to viscous, soluble, flowable, relatively low-molecular-weight polymers that, when subjected to ionizing radiation, become insoluble and infusible, and more specifically to telomerized polyesters that are converted to three-dimensional crosslinked, insoluble, infusible polymers at relatively low radiation doses. The examples given are linear polyesters derived from the condensation of saturated or unsaturated aliphatic polycarboxylic acids with saturated or unsaturated polyhydric alcohols whose end groups contain the highly radiation-sensitive acryloxy-group such as diacrylyl polyesters. Methods of preparation are described. (UK)

51498 ELECTRON-BEAM CURING OF PAINT COATING. Ishiwatari, Junsuke (Kansai Paint Co. Ltd., Hiratsuka, Japan). Toso To Toryo: No. 191, 61-72(Oct 1970). (In Japanese).

Advantages of the electron beam process for curing of paints are a rapid curing reaction, no increase in temperature of materials, and no need for catalytic agents. The process may be applied to metals, wood, textiles, paper, and plastics. The mechanism of electron beam curing is explained. The effects of paint additives, radiation dose, and atmosphere on the curing process are discussed. The effective beam penetration depth is proportional to acceleration voltage and inversely proportional to material density. (TSS)

51499 DETERMINATION OF THE ABSOLUTE VALUE OF THE RATE CONSTANT OF THE REACTION OF BRANCHING AND THE RATE OF THERMAL GENERATION OF INITIATING CENTERS FOR A CHAIN REACTION WITH DEGENERATE BRANCHES BY A RADIATION CHEMICAL METHOD. Poluektov, V. A.; Ageev, N. G. High Energy Chem. (USSR) (Engl. Transl.); 4: No. 5, 403-4(Sep-Oct 1970).

Translated from Khim. Vys. Energ.; 4: No. 5, 452-3(Sep-Oct 1970).

It has been previously reported that for many compounds the average value of the radiation yield of active particles, $G_0 \simeq 3.8$. With this value known, by initiating a chain reaction with degenerate branches by ionizing radiation, the rate constant of branching and the rate of generation of the initial centers of the thermal reaction can be determined. These values were determined with the liquid-phase oxidation of hexachlorobutadiene by gaseous oxygen as an example. For this purpose the effects of γ-radiation on the rate of of oxidation were investigated. The kinetic curves of the oxidation at 120°C are presented. Increasing the dose rate to 1.8×10^{16} eV/cm$^3 \cdot$ sec leads to a significant decrease in the induction period and does not affect the rate of oxidation outside the induction period. (auth)

51500 γ-RADIATION-INDUCED OXIDATION OF ACENAPHTHENE. PART II. USING MOLECULAR OXYGEN. Tarabasanu-Mihaila, Doina; Tarabasanu-Mihaila, C. Rev. Chim. (Bucharest); 21: No. 11, 689-91(Nov 1970). (In Rumanian).

Following previous studies on the selective oxidation of acenaphthene to naphthalic acid in a solution of potassium permanganate-pyridine under the influence of γ radiation, molecular oxygen was tested as a direct oxidizing agent in a mixture of benzene–pyridine. An $FeSO_4$-type chemical dosimeter was used to measure the γ radiation dose. Increase of the pyridine was found to help to increase the yield of naphthalic acid; use of $KMnO_4$ and cobalt naphthenate as a catalyst yielded good results. The basicity of pyridine favorized the radiochemical decomposition of the $KMnO_4$. The strong delayed effect observed is attributed to a radical-based chain reaction, resulting in the formation of peroxide-type intermediary products which induce a continued reaction of acenaphthene with the molecular oxygen in the system. Best results were obtained when the naphthalic acid conversion reached 20%. (auth)

51501 RADIATION-INDUCED CROSSLINKING OF CELLULOSE WITH ACROLEIN. Ishanov, M. M.; Azizov, U. A.; Nigmankhodzhaeva, M. S.; Usmanov, Kh. U. (Research Inst. for Cotton Cellulose Chemistry and Tech., Tashkent). J. Polym. Sci., Part A-1; 9: No. 4, 1013-25(Apr 1971).

The process of radioinduced crosslinking of cellulose is highly influenced by radiation dosage and dose as well as by the solvents used and their concentration. The best crease resistance was obtained in cases when cellulose is crosslinked with acrolein in the vapor phase. Moreover, the process is entirely radiation-induced and practically no homopolymer is formed. Chemical analysis and investigations of infrared spectra indicate that crosslinking proceeds on vinyl as well as on aldehyde groups of acrolein. (auth)

51502 RADIATION-INDUCED REARRANGEMENT OF ETHYLENE GLYCOL IN AQUEOUS SOLUTION. Burchill, C. E.; Perron, K. M. (Univ. of Manitoba, Winnipeg). Can. J. Chem.; 49: 2382-9(15 Jul 1971).

Under γ-irradiation, aqueous solutions of ethylene glycol containing hydrogen peroxide form acetaldehyde as a major product via a free-radical chain rearrangement. The yield of acetaldehyde is essentially unchanged when hydrogen peroxide is replaced by N_2O or $HClO_4$. A mechanism is proposed in which the glycol radical, $CHOHCH_2OH$, rearranges to the acetaldehyde precursor, CH_2CHO, followed by the hydrogen atom transfer reaction; $CH_2CHO + (CH_2OH)_2 \rightarrow CH_3CHO + CHOHCH_2OH$ thus propagating a chain reaction. The rearrangement is also induced by the photodissociation of H_2O_2 in aqueous solutions of ethylene glycol. (auth) (Canada)

Radiolysis

Refer also to abstracts 51370, 51908, 51990, 51995, 52004, and 52914.

51503 (A/CONF.49/P–647) APPLICATION OF RADIATION TECHNIQUES FOR CURING OF SURFACE COATINGS AND FOR PREPARATION OF WOOD-POLYMER AND CONCRETE-POLYMER MATERIALS. Singer, K. (Danish Atomic Energy Commission, Risoe. Research Establishment); Vinther, A.; Batsberg Pedersen, W.; Dalager, P.; (and others) Jun 1971. 13p. (CONF-710901–308). Dep. NTIS (U. S. Sales Only).

Prepared for 4th International conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Research activities in Denmark within three areas that are all based upon radioinduced polymerization reactions are described. Experimental work under way on electron beam curing of surface coatings is mainly concerned with paint systems based on modified acrylics and polyesters. Coatings with suitable application viscosities have been cured with absorbed radiation doses of less than 1 Mrad. The studies were performed with Risö's 10-MeV linear electron accelerator. The recent installation at Risö of a new, low-energy electron accelerator (400-keV, 20-kW, 120-cm scanwidth ICT machine from High Voltage Engineering Corporation) implies that work in this field now will increase to pilot plant scale in close collaboration with Scandinavian industry. Recent development work concerning the preparation of irradiated wood–plastic parquet flooring material by means of 10-MeV electrons from a 10-kW linear electron accelerator is discussed. The material consists of combinations of Danish maple and oak with modified acrylic polymers. Recent experimental work on gamma-radiation-cured composites based on other porous materials is also discussed. These include light-weight concrete, normal-strength concrete and high-strength vibropressed concrete, various hard-compressed cement-sand mortars, sandlime bricks, and plaster of Paris impregnated with different vinyl monomers. A preliminary cost evaluation for the production of radiation-cured plastic-impregnated concrete pipes is included. (auth)

51504 (A/CONF.49/P–668) RADIATION POLYMERIZATION OF MONOMER IMPREGNATED SOUTH AFRICAN TIMBERS. Basson, R. A. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). May 1971. 14p. (CONF-710901–314). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The problems encountered with the use of certain, potentially valuable South African timbers are outlined and feasibility of upgrading these by the process of wood–plastic formation is discussed. Three pine and three eucalyptus species were chosen for the initial study. These were impregnated with a variety of monomers, some of which are manufactured locally and for which wider uses are being sought. Although the pine species are readily impregnated, the uptake in eucalyptus woods is small. Conditions affecting monomer uptake were investigated and some promising methods of improving this were developed. An impregnator was constructed and allows the treatment of specimens large enough for commercial evaluation. The distribution of monomer in the larger samples was determined by the incorporation of dyes and by radio-densitometer measurements. Some indication of the local distribution in the fine structure of the wood was obtained by microscopy. A number of factors influencing the rate of polymerization were studied, including monomer purity, naturally occurring inhibitors, oxygen content, and dyestuff concentration. Complete conversion curves were obtained at a number of dose rates and minimum doses were determined from these. A series of mechanical and weathering tests were carried out and indicate substantial improvements over the untreated wood. Preliminary cost estimates indicate that the use of these materials may be economically viable. The construction of a pilot plant to test these conclusions is under consideration. (auth)

51505 (AD–715391) ION-PAIR YIELDS AND KINETIC BEHAVIOR OF FREE CHARGES IN NONPOLAR LIQUIDS. Capellos, Christos (Picatinny Arsenal, Dover, N. J.). Nov 1970. 34p. (PA-TR–4054). NTIS.

Yields of $(C_6H_5)_3C^+$ were determined by microsecond and nanosecond pulse radiolysis of triphenylmethyl chloride solutions in five solvents (n-hexane, cyclohexane, 2,2,4-trimethylpentane, carbon tetrachloride, and carbon disulfide). These yields are in excellent agreement with the ion-pair yields determined for the same solvents by conductivity methods. In addition, the triphenylmethyl chloride method allows measurements of rate constants for proton-transfer and ion-recombination reactions, as well as the study of the reactivity of model compounds of explosives, or explosives themselves, towards the positive charge. (USGRDR)

51506 (AD–721299) INFLUENCE OF SOLUTION STRUCTURE ON HYDRATED ELECTRON REACTIONS. Klein, Nathan (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Feb 1971. 45p. (BRL–1531). NTIS.

The ultra-fast, apparent second-order decay of the hydrated electron, e^-aq, following nanosecond duration radiation pulses in air-free alkaline solution is discussed in detail. The proposed structure and properties of $H_2O^+_{aq}$ are described and reactions of this non-classical ion are discussed. The importance of solution structure in charge migration and the effect of various salts on solution structure is reviewed. (USGRDR)

51507 (AD–722057) AROMATIC SOLUTE MOLECULAR-ION AND TRIPLET-STATE FORMATION IN POLYSTYRENE AND POLYMETHYLMETHACRYLATE. Siegel, Seymour; Stewart, Thomas B. (Aerospace Corp., El Segundo, Calif.). 15 Jan 1971. Contract F04701-70-C-0059. 61p. (SAMSO-TR–71-62). NTIS.

Solutions of naphthalene-d_8 and N,N,N′,N′-tetramethyl-p-phenylenediamine (TMPD), singly and in combination, in polystyrene (PS) and polymethylmethacrylate (PMMA) were irradiated by 1.9-MeV electrons at 86°K. The irradiation pulse had a half width of 0.7 sec. Examination of the absorption spectra of samples immediately after the irradiation pulse indicated that solute triplet-state molecules and positive-ion molecules were produced, with TMPD as the solute in both polymer hosts. With naphthalene, positive ions were observed only in PMMA, whereas triplet-state molecules were observed in both polymers. Analysis of the data from the mixed-solute samples indicates that the presence of 0.05 M TMPD captures all of the mobile positive charge, even when the naphthalene concentration is as high as 0.2 M. The radiation yields of triplets and ions in the two polymers are discussed and compared. PMMA is just as effective as PS in producing triplet excited states of the aromatic solute in terms of limiting yields at high solute concentration, but the concentration dependence is different in the two polymers. Deductions were made with regard to charge capture and migration in these systems. (auth) (USGRDR)

51508 (CONF-711001–(Vol.2), pp 560-72) PULSE RADIOLYSIS OF LANTHANIDES AQUEOUS SOLUTIONS. Faraggi, M.; Feder, A.; Tendler, Y. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Pulse radiolysis of aqueous solutions generates e^-_{aq} and OH radicals. The reactions of e^-_{aq} with Eu(III), Yb(III), and Sm(III) and those of OH radicals with Pr(III) were investigated. Absorption spectra of the transient species produced were assigned to the Laporte allowed transition between 4f and $4f^{n-1}$ $5d^1$ level of the divalent ions Eu, Yb, and Sm and of the tetravalent Pr. The excitation energy values E_{fd} for these ions in aqueous solutions are in good agreement with those found or calculated in crystals. The specific rates of reactions of Eu(II), Yb(II), and Sm(II) with various oxidants and the electron transfer reaction of Sm(II) with Yb(III) and with Eu(III) were determined. The order of reactivity is Sm(II) > Yb(II) > Eu(II); this order is correlated with the electrode potential E^0 of divalent ions. The rate of the reaction of OH radicals and Pr(III) was determined by four different methods and the rate constant was found to be $1-4 \times 10^6$ M^{-1} sec^{-1}. The variation of the optical density of Pr(IV) ions with pH leads to the conclusion that the form of Pr(IV) is $Pr(OH)^{3+}$, and Pr^{4+} in neutral and acid solutions, respectively. The equilibrium constant of hydrolysis was found to be 7×10^{-4}. The specific reaction rate constants of Pr(IV) with different OH scavengers were determined. (auth)

51509 (FRNC-TH–221) ELECTRON SPIN RESONANCE STUDY OF THE RADICALS OBTAINED IN GASEOUS PHASE BY LOW ENERGY ELECTRON IMPACT. Wallart, Marc (Paris Univ., Orsay (France). Faculte des Sciences). 16 Jun 1970. 95p. (In French). Dep. NITIS (U. S. Sales Only).

Thesis.

Data on radiolysis in the gaseous phase, ESR theory, and the movement of radicals in their matrix, and the apparatus and experimental conditions used are reviewed. Neopentane, C_5H_{12}, was studied (observation of various radicals and their movements in their matrix; review on the bibliographical data on C_5H_{12} radiolysis in the gaseous phase; results on the formation of radicals as a function of gas pressure and electron energy; results on the ions obtained by mass spectrometry and cyclotron resonance). The radiolysis of isobutane C_4H_{10} and isobutene C_4H_8 was also studied. (France)

51510 (KFKI–71-23) RADIOLYSIS OF HYDROCARBON MIXTURES. Roder, M. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1971]. 12p. (CONF-710517–2). Dep. NTIS (U. S. Sales Only).

From third symposium on radiation chemistry; Tihany, Hungary (10 May 1971).

The radiolysis of cyclohexane–hexamethylbenzene (HMB), benzene–HMB and toluene–HMB mixtures was studied and the yields of the main gaseous products, hydrogen and methane, were determined. Results show that in spite of the charge transfer to HMB being exothermic by more than 1.0 eV there are no apparent interactions between benzene and HMB or between toluene and HMB, and HMB shows a protective effect in cyclohexane decomposition similar to that for benzene towards cyclohexane. (D.H.M.)

51511 (ORO–3106-41) RADIATION CHEMISTRY OF HYDROCARBON AND ALKYL HALIDE SYSTEMS. Eighth Annual Progress Report, August 1970–July 1971. Hanrahan, Robert J. (Florida Univ., Gainesville. Dept. of Chemistry). 31 Jul 1971. Contract AT(40-1)-3106. 20p. Dep. NTIS.

Progress is reported of research on the radiation chemistry of hydrocarbon and allyl halide systems including product identification and measurement of G values for product formation in both C_2H_6 and C_2F_6 as a function of dose in the range 1.5×10^{20} and 1.5×10^{21} eV/gram; gas-phase radiolysis of C_2H_5Br; glow discharge studies on fluorocarbon systems; high-pressure mass spectrometry; and development of computerized mass spectrometer data acquisition and reduction system. (D.H.M.)

51512 (UJV–2616-Ch) RADIOLYSIS OF LOW-CONCENTRATION SOLUTIONS OF TRIFLUOROCHLOROETHYLENE IN 2-PROPANOL. Chutny, B.; Vanek, K. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). May 1971. 14p. (CONF-710517–3). Dep. NTIS (U. S. Sales Only).

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From third symposium on radiation chemistry; Tihany, Hungary (10 May 1971).

A study of the radiolysis of low trifluorochloroethylene in 2-propanol is reported that includes the mechanism for hydrogen, acetone, and telomer formation. (D.H.M.)

51513 ELECTRON SPIN RESONANCE STUDIES OF FUNDAMENTAL PROCESSES IN RADIATION- AND PHOTO-CHEMISTRY. PART 7. THE γ-RADIOLYSIS OF CARBOXYLIC ACIDS AT CRYOGENIC TEMPERATURES. Ayscough, P. B.; Oversby, J. P. (Univ. of Leeds, Eng.). Trans. Faraday Soc.; 67: No. 581, 1365-75(May 1971).

The γ radiolysis of eleven carboxylic acids at cryogenic temperatures was examined by ESR and matrix isolation techniques. Radical-anions $\dot{R}COOH^-$ were identified in all the acids examined except cyclopropanecarboxylic acid, and their reactions studied. The main features of the radiolysis may be interpreted by means of a mechanism similar to that proposed earlier for acetic acid. (auth) (UK)

51514 UNSTABLE INTERMEDIATES. PART XCV. ELECTRON SPIN RESONANCE SPECTRA ASSIGNED TO THE RADICALS $POCl_3^-$, $POCl_2$, PO_2Cl_2, PCl_2, AND PCl_4 IN γ-IRRADIATED $POCl_3$, PCl_3, AND PCl_5. Begum, A.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 12, 2065-9(1971).

After exposure of phosphoryl chloride to ^{60}Co γ rays at 77°K, three radical species were detected. One, having a large ^{31}P hyperfine coupling of about 1350 G is thought to be $POCl_3^-$, having two strongly coupled chlorine atoms (A_{iso} 66 G) and one weakly coupled chlorine atom (A_{iso} ca. 20 G). The second species, thought to be $POCl_2$ gave an axially symmetric spectrum at 77°K, but this became isotropic on warming the sample to 100°K, when $Al_{iso}(^{31}P)$ was 759 G and $A_{iso}(^{35}Cl)$ was 18 G. The third major species, thought to be PO_2Cl_2, had $A_{iso}(^{31}P)$ 43 G and $A_{iso}(^{35}Cl)$ 3 G. This species was probably formed from HPO_2Cl_2 impurity. With similar treatment, phosphorus trichloride gave PCl_2 and PCl_4 radicals while the pentachloride gave PCl_4 and an unidentified radical containing two chlorine atoms. (auth) (UK)

51515 INVESTIGATION OF FREE RADICALS OF GAMMA-IRRADIATED CELLULOSE DERIVATIVES BY EPR. Khamidov, D. S.; Azizov, U. A.; Milinchuk, V. K.; Usmanov, Kh. U. (Inst. of Chemistry and Tech. of Cotton Cellulose, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 11, 33-4(1970). (In Russian).

The effect of the side groups in cellulose derivatives was studied with respect to the radiation-chemical production of free radicals. The di- and tri-acetates of cellulose (CDA and CTA) were prepared and gamma-irradiated at 77, 193, and 300°K, using untreated cotton cellulose as a reference standard. Free-radical production from the esters decreased with a rise in temperature, but that from cellulose increased. The EPR spectra of the esters were altered considerably. (K.S.W.)

51516 SH GROUP COMPOSITION OF YEAST ALCOHOL DEHYDROGENASE BY ^{60}Co-γ-RADIATION. Ganzke, I.; Tapp, E.; Siegel, G. (Humbolt-Univ., Berlin). Radiobiol.-Radiother.; 11: No. 3, 329-33(1970). (In German).

The radiation-induced SH-group-decomposition of yeast alcohol dehydrogenase in aqueous solution was studied. The radiation-chemical yield, G(-SH), depends on the SH initial concentration within the range from 4×10^{-5}M to 9×10^{-4}M. (auth)

51517 POSSIBILITY OF RELATING MASS SPECTRA TO RADIOLYTIC FRAGMENTATION BY MATRIX CALCULATIONS. Cosandey, Maurice (Institut de Chimie-Physique, Lausanne, Switzerland). Chima (Aarau); 25: No. 6, 191-2(15 Jun 1971). (In French).

A new semi-empirical relation is proposed to relate the radiolytic ionic fragmentation in the vapor phase to the mass spectrum of hydrocarbons. Extensive use is made of the cross sections of the various ion-molecule reactions of the fragment ions. Numerical calculation is carried out for cyclohexane. (auth)

51518 ELECTRON SCAVENGING IN THE RADIOLYSIS OF MIXTURES CONTAINING HYDROGEN SULFIDE. Forys, M.; Migdal, E. (Univ., Warsaw). Radiochem. Radioanal. Lett.; 7: No. 3, 181-3(1 Aug 1971).

Ethane and ammonia were subjected to α radiolysis in the gas phase in the presence of hydrogen sulfide and nitrous oxide. Competition in electron scavenging between hydrogen sulfide and nitrous oxide was found to occur in both gases. (auth)

51519 DOSE RATE EFFECTS IN THE STEADY AND PULSE RADIOLYSIS OF LIQUID CHLOROFORM. Bibler, Ned E. (Savannah River Lab., Aiken, S. C.). J. Phys. Chem.; 75: No. 16, 2436-42(5 Aug 1971).

The effect of dose rate on the 100-eV yields of organic products in the radiolysis of chloroform was studied at intensities of 1.6×10^{16} and 17×10^{16} eV/g-sec using a ^{60}Co γ source and at maximum instantaneous dose rates of 2.5×10^{24} and 6.4×10^{24} eV/g-sec using a pulse x-ray generator. The radiolysis products were CH_2Cl_2, C_2Cl_4, CCl_4, sym-$C_2H_2Cl_4$, C_2HCl_5, and C_2Cl_6. As the dose rate increased, $G(CH_2Cl_2)$ and $G(C_2Cl_6)$ decreased, $G(C_2H_2Cl_4)$ and $G(C_2HCl_6)$ increased, and $G(C_2Cl_4)$ and $G(CCl_4)$ remained unchanged. These results are consistent with a free-radical mechanism involving the reaction of Cl and $CHCl_2$ radicals with $CHCl_3$ to produce CCl_3 radicals. The dose rate effects result from a competition between $CHCl_3$ molecules and radicals for the $CHCl_2$ radicals, with higher dose rates favoring the radical–radical reactions. The observed 100-eV yields in both the steady and pulse radiolysis experiments agreed with those calculated by the application of the previously proposed independent action model. A value of 1.3 ± 0.2 M^{-1} sec^{-1} was determined for the rate constant for the reaction of $CHCl_2$ radicals with $CHCl_3$ at 25° from the steady radiolysis experiments, and the magnitude of this value was confirmed by the results of the pulse radiolysis experiments. The results of the pulse radiolysis experiments suggest that the rate constant of Cl atom attack on $CHCl_3$ is lower in the liquid than in the vapor phase. Evidence is also presented that indicates that Cl atoms and $CHCl_2$ radicals are not radiolytically formed with equal 100-eV yields. (auth)

51520 PEROXIDES PRODUCED FROM THYMINE BY γ IRRADIATION IN AERATED SOLUTION. Cadet, J.; Teoule, R. (CEN, Grenoble, France). Biochim. Biophys. Acta; 238: No. 1, 8-26(Apr 1971). (In French).

Thymine hydroperoxides were the primary products from thymine on γ irradiation in aerated solution. The following hydroperoxides were identified: trans-5-hydroperoxy-6-hydroxy-5,6-dihydrothymine, cis-5-hydroperoxy-6-hydroxy-5,6-dihydrothymine, cis-6-hydroperoxy-5-hydroxy-5,6-dihydrothymine, 5-hydroperoxymethyl uracil, 5-hydroperoxy-5,6-dihydrothymine, cis-6-hydroperoxy-5,6-dihydrothymine, trans-6-hydroperoxy-5,6-dihydrothymine, trans-5,6-dihydroperoxy-5,6-dihydrothymine, 5-hydroperoxy-5-methylhydantoin, and 5-hydroperoxy-5-methylbarbituric acid. These compounds were separated by thin-layer chromatography involving new chromatographic solvents. By decomposition they were converted into alcohol besides other degradation products. These ^{14}C-labeled peroxides were synthesized by different methods, which are described. A new way to obtain thymine peroxides based on the reaction of H_2O_2 with halogenated derivatives of thymine in the presence of Ag_2O is given. (auth)

51521 RADIOLYSIS OF POLYMETHYLMETHACRYLATE IN THE PRESENCE OF ETHYLMERCAPTAN. I. MAIN CHAIN SCISSION AND VOLATILE PRODUCTS FORMATION. David, C.; Fuld, D.; Geuskens, G. (Univ. Libre, Brussels). Makromol. Chem.; 139: 269-76(1970).

Main chain scission yields G_s are, respectively, 0.88 and 2.6 for poly(methyl methacrylate) (PMM) irradiated at 77 and 313°K. G values for volatile products (mainly CH_4, CO, CO_2, and $HCOOCH_3$) were measured. The ratio of methyl-containing volatiles to main chain scission yield is about one at both temperatures. In the presence of ethyl mercaptan, very efficient protection is observed for main chain scission whereas the amount of volatile products is little or not affected. These results show that side chain scission and main chain breaking are closely related and that the former process precedes and induces the latter. A mechanism is proposed. (auth)

51522 EFFECTS OF DOSE, DOSE RATE, AND TRACE IMPURITIES ON n-HEXADECANE RADIOLYSIS. Falconer, W. E.; Salovey, R.; Sunder, W. A.; Walker, L. G. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Radiat. Res.; 47: No. 1, 41-50 (Jul 1971).

In the irradiation of liquid n-hexadecane, yields of hydrogen, methane, dimer, and low-molecular-weight scission products are independent of dose. In the solid state, hydrogen and to a lesser extent dimer yields decrease with increasing dose, whereas the scission products increase. In both states, yields of hydrogen and dimer are independent of dose rate between 2.5 and 300×10^{18} eV g^{-1} $minute^{-1}$. Trace impurities in n-hexadecane samples significantly affect radiolytic yields. In the solid state impurities enhance some yields, in contrast to the more usual suppression observed in the liquid. A phenomenological model for these effects based on energy localization by impurities is discussed. (auth)

51523 ROLE OF THE REACTION OF e_{aq}^- WITH Fe^{III} IN THE RADIATION CHEMISTRY OF ACID AQUEOUS SOLUTIONS. Czapski, Gideon; Meisel, D. (Hebrew Univ., Jerusalem). Int. J. Radiat. Phys. Chem.; 3: No. 1, 11-16(Jun 1971).

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The reaction $e_{aq}^- + Fe^{III} \xrightarrow{k_1} Fe^{2+}$ was investigated by competition with the reaction $e_{aq}^- + H^+ \xrightarrow{k_2} H$. In acid solutions of alcohol, $G(H_2)$ was reduced very efficiently by Fe^{III}. κ_1/κ_2 was determined in $HClO_4$ and H_2SO_4 and it was found to depend on the form of Fe^{III} ion in solution. At pH 1.8, $\kappa_1/\kappa_2 \approx 2$ in both $HClO_4$ and H_2SO_4. Inclusion of this reaction in the mechanism of oxidation of Fe^{2+} in acid solutions (which has been generally neglected) confirms, as suggested by Schwarz 1964, that $G_{e_{aq}^-}$ seems to be almost pH independent. It also removes the necessity of assuming the existence of $H_2O_2^+$ which was proposed (Pucheault et al., NSA-23 28887) in order to interpret the variation of $G(Fe^{III})$ in acid air-saturated Fe^{III}/Fe^{2+} solutions. (auth) (UK)

51524 RADIOLYSIS OF LEAD AZIDE. Ryabykh, S. M.; Zakharov, Yu. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 13: No. 12, 1737-9(1970). (In Russian).

The radiolysis of lead azide was studied by measuring the rate of nitrogen gas evolution into a vacuum. Chemically pure PbN_6 was prepared and subjected to x radiation so that the absorption rate was 4.3×10^{16} eV/g · sec. The temperature range from 1 to 90°C was explored for this reaction. The volume of radiolytic gas was determined from the pressure increase, and its evolution rate was practically constant. The logarithm of the rate of nitrogen production was a linear function of the reciprocal temperature. (K.S.W.)

51525 ISOTOPIC EFFECT DURING THE RADIOLYSIS OF FROZEN AQUEOUS SOLUTIONS OF ACIDS. Bugaenko, L. T.; Zador, E.; Belevskii, V. N.; Golubev, V. B. (Moscow State Univ.). High Energy Chem. (USSR) (Engl. Transl.); 4: No. 5, 421-2(Sep-Oct 1970).

Translated from Khim. Vys. Energ.; 4: No. 5, 468-9(Sep-Oct 1970).

The isotopic enrichment of atomic hydrogen in radiolysis of frozen solutions of perchloric acid and sulfuric acid was studied. The isotopic enrichment factor was essentially constant at 2.0 ± 0.4 over the entire range of isotopic composition. (M.C.G.)

51526 LIMITING CONCENTRATIONS OF STABILIZED FREE RADICALS DURING IRRADIATION OF SEVERAL AROMATIC COMPOUNDS. Tolkachev, V. A.; Sokolov, I. B. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). High Energy Chem. (USSR) (Engl. Transl.); 4: No. 5, 423-4 (Sep-Oct 1970).

Translated from Khim. Vys. Energ.; 4: No. 5, 469-70(Sep-Oct 1970).

Results from radiolysis of aniline show that the destruction of radicals during irradiation may not be the single reason for the low limiting concentrations of free radicals in polar aromatic compounds. It was concluded that at doses greater than 300 Mrad a decrease in the stability of the lattice near the sites of stabilization of the radicals that disappear in the low-temperature region occurs in aniline. (M.C.G.)

51527 DISPROPORTIONATION AND RECOMBINATION REACTIONS OF CYCLOHEXYL RADICALS AT LOW TEMPERATURES. Makarov, V. A.; Filatov, E. S. (Moscow State Univ.). High Energy Chem. (USSR) (Engl. Transl.); 4: No. 5, 419-20 (Sep-Oct 1970).

Translated from Khim. Vys. Energ.; 4: No. 5, 467-8(Sep-Oct 1970).

The disproportionation and recombination of cyclohexyl radicals were investigated at 77 to 145°K. The radicals were formed by low-temperature addition of hydrogen to cyclohexene or γ radiolysis of cyclohexane. The ratio of the rate constants of the disproportionation and recombination reactions was calculated. (M.C.G.)

51528 PULSE RADIOLYSIS AND POLAROGRAPHY: HALF-WAVE POTENTIALS FOR OXIDATION AND REDUCTION OF SHORT-LIVED ORGANIC RADICALS ON THE Hg ELECTRODE. Lilie, J.; Beck, G.; Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges. Phys. Chem.; 75: No. 5, 458-65(May 1971). (In German).

A method for the polarography of short lived radicals ($<10^{-4}$ s) is described. The radicals are produced by a 50 ns pulse of high energy electrons in the vicinity of a dropping mercury electrode. The polarogram is obtained by recording the current vs. time curve at various potentials of the electrode. The aqueous solutions contained nitrobenzene, saturated alcohols, benzene and formic acid at low concentrations. Radicals are formed from these substances by the attack of the radiolytically produced hydrated electrons or hydroxyl radicals. The half wave potential of the oxidation of α-alcohol radicals is more negative for the basic form of a radical than for the acid form. $E_{1/2}$, for example, amounts to −0.98 V for $\cdot CH_2OH$ and −1.73 V for $\cdot CH_2O^-$ (vs. saturated calomel electrode). A reduction at high negative potentials could only be achieved in the case of the $\cdot CH_2OH$ radical (−1.8 V). It can be predicted from the measured half wave potentials, whether a solute can be reduced by an α-alcohol radical. The comparison with known electron transfer reaction shows that the half wave potential of the oxidation of an α-alcohol radical should be more negative by a few 0.1 V than the half wave potential of the reduction of an organic electron acceptor. β-alcohol radicals are readily reduced at the mercury electrode. The half wave potential of the hydroxycyclohexadienyl radical is remarkably low which is attributed to the resonance stabilization of the intermediate anion. The oxidation of β-alcohol radicals starts at about zero V (vs. saturated calomel electrode). The poor reduction capability of these radicals towards various substances is explained this way. The half wave potentials of the oxidation and reduction of the carboxyl radical are relatively close together. This effect was observed for both the acid form COOH and the base form CO_2^-. (auth)

51529 MEASUREMENT OF ION–MOLECULE REACTIONS IN THE GAS PHASE BY PULSE RADIOLYSIS OF N_2^+ $(^2\Sigma_g^+)$ AS AN EXAMPLE. Perner, D.; Dreyer, J. W. (Kernforschungsanlage, Juelich, Ger.). Ber. Bunsenges. Phys. Chem.; 75: No. 5, 420-6 (May 1971). (In German).

An absorption spectroscopic method is described which can be used to measure the kinetics of thermal ions with a time resolution of less than 10 ns. The method was applied to N_2^+ $(^2\Sigma_g^+; v'' = 0)$ reactions and the following rate constants were determined: $k_{N_2^+ + N_2} = (1.1 \pm 0.2) \cdot 10^{13}\ l^2 \cdot mol^{-2} \cdot s^{-1}$, $k_{N_2^+ + NO} = (2.5 \pm 0.3) \cdot 10^{11}\ l \cdot mol^{-1} \cdot s^{-1}$, $k_{N_2^+ + 1.3-butadiene} = (8.1 \pm {}^{0.2}_{1.4}) \cdot 10^{11}\ l \cdot mol^{-1} \cdot s^{-1}$, $k_{N_2^+ + cyclo-propane} = (8.9 \pm 0.5) \cdot 10^{11}\ l \cdot mol^{-1} \cdot s^{-1}$, $k_{N_2^+ + NH_3} = (1.1 \pm 0.2) \cdot 10^{12}\ l \cdot mol^{-1} \cdot s^{-1}$, $k_{N_2^+ + O_2} \leq 5 \cdot 10^{10}\ l \cdot mol^{-1} \cdot s^{-1}$. (auth)

51530 UNSTABLE INTERMEDIATES. PART XCVI. THE EFFECT OF HYDROGEN-BONDING ON THE E.s.r. PARAMETERS FOR NH_2, NH_3^+, AND H_2CN [γ IRRADIATED AMMONIUM PERCHLORATE]. Rao, K. V. S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 13, 2163-6(1971).

The isotropic hyperfine coupling to ^{14}N increases markedly for both NH_2 and H_2CN when these radicals are hydrogen-bonded to the matrix. This is discussed in terms of two models: in one attenuation of lone-pair electrons results in increased spin-polarization, and in the other hydrogen-bonding changes the structure so that 2s-character is added directly to the nominally 2p-orbital of the unpaired electron. To do this for NH_2, a zero-point bending is required, which must also occur for the conjugate acid, NH_3^+. In support of this there is a marked fall in $A_{iso}(^{14}N)$ (19.3 to 17.3 G) on going from NH_3^+ to ND_3^+. For H_2CN the effect can also be understood by analogy with that expected for complete protonation, since the conjugate acid H_2CNH^+, isoelectronic with $H_2C = \dot{C}H$, is expected to be non-linear with respect to the C–N–H bonds. (auth) (UK)

51531 ACTION OF γ-IRRADIATION ON AQUEOUS NICOTINIC ACID AND NICOTINIC ACID AMIDE SOLUTIONS WITH AND WITHOUT ADDITION OF ASCORBIC ACID. Washuettl, J. (Technische Hochschule, Vienna). Microchim. Acta; No. 3, 539-46(1971). (In German).

Studies of the extent of the destruction of nicotinic acid and nicotinic acid amide in aqueous solution of various concentrations with and without addition of ascorbic acid through γ irradiation with 5, 50, and 500 krads were conducted. The determination of the undecomposed B-vitamin was carried out by means of a dc procedure and also by a modified Proctor and Goldblith method. The dc procedure was more specific. The differences in the analytical results given by the two methods are discussed. The degradation of the nicotinic acid and its amide began even with 50 krads provided they were present at low concentrations. Addition of ascorbic acid under these circumstances had neither an inhibiting nor a favoring influence. The degradation of dilute solutions of nicotinic acid and nicotinic acid amide was greater under 500 krad irradiation, while the addition of ascorbic acid partially inhibited the radiolytic destruction of the two vitamins. The degradation of nicotinic acid and its amide was greater at increasing dilution. A marked radiolysis was attained only with 500 krads at high concentrations. (auth)

51532 · PYRENE DIMER CATION AS STUDIES BY PULSE RADIOLYSIS. Kira, Akira; Arai, Shigeyoshi; Imamura, Masashi (Inst. of Physical and Chemical Research, Wako, Japan). J. Chem. Phys.; 54: No. 11, 4890-5(1 Jun 1971).

Radical cations of pyrene were investigated by the pulse radiolysis technique in solutions of benzonitrile, acetone, and dichloroethane. A 450-nm absorption band of a pyrene monomer

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cation was replaced by new bands with maxima at 500, 580, and 750 nm as the pyrene concentration was increased. The latter absorption bands were exclusively assigned to a pyrene dimer cation in equilibrium with the monomer cation at room temperature. Equilibrium constants evaluated were (2.7 ± 0.2) × 10^2 and (5.1 ± 0.5) × 10^2 M^{-1} at 20°C for benzonitrile and acetone solutions, respectively. The decay processes of both the monomer and dimer cations were discussed. In addition, rate constants of the reactions of both the monomer and dimer cations with triethylamine were found to be 2.7 × 10^9 and 5.4 × 10^8 $M^{-1} \cdot sec^{-1}$, respectively. (auth)

51533 YIELD OF SOLVATED ELECTRONS DURING γ-RADIOLYSIS OF ALKALINE METHANOL. Sibirskaya, G. K.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 4: No. 5, 427-8(Sep-Oct 1970).

Translated from Khim. Vys. Energ.; 4: No. 5, 472-3(Sep-Oct 1970).

The G-value for solvated electrons was determined during the γ radiolysis of deaerated methanol containing 0.1 M of alkali. The dose rate was ~10^{16} eV/ml · sec. NO_3^- ions were used for determination of the solvated electrons since they are effective acceptors. The value for G(NO_2^-) for any NO_3^- concentration was substantially higher in methanol containing alkali than in neutral alcohol. The yield of NO_2^- was 1.5 to 1.8 ions/100 eV. G_{e_s} was apparently equal to this value. (M.C.G.)

51534 INVESTIGATION OF THE ACTION OF PROTON AND MIXED γ-NEUTRON RADIATION ON TIN COMPOUNDS BY THE MOESSBAUER METHOD. Shipatov, V. T.; Seregin, P. P.; Eremin, L. P.; Bondarevskii, S. I. (Leningrad State Univ. Inst. of Semiconductors, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 4: No. 5, 429-30(Sep-Oct 1970).

Translated from Khim. Vys. Energ.; 4: No. 5, 474-5(Sep-Oct 1970).

The effects of both mixed γ-neutron radiation of a reactor as well as ionizing charged particles on the nuclear γ resonance of simple divalent tin compounds with elements of the sixth and seventh groups of the periodic system were investigated. An intense Sn(IV) line with a chemical shift close to the chemical shift of SnO_2 appears in the nuclear γ resonance spectra of proton-irradiated tin halides. The spectra did not change on reactor irradiation of tin halides. For SnO irradiation with protons did not lead to the appearance of a Sn(IV) line, whereas reactor irradiation did cause the appearance of an intense Sn(IV) line. Irradiation of SnS, SnSe, and SnTe with protons also failed to cause the appearance of the Sn(IV) line. (M.C.G.)

51535 ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF IRRADIATED FROZEN AQUEOUS SOLUTIONS. XI. RADICAL PRODUCTS OF RADIOLYSIS OF AQUEOUS SOLUTIONS OF SULPHURIC AND PHOSPHORIC ACIDS AT 77°K AND THEIR PROPERTIES. Ershov, B. G.; Mustafaev, A. I.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). Int. J. Radiat. Phys. Chem.; 3: No. 2, 71-84(Aug 1971). (In Russian).

Results of studies of free radicals in γ-irradiated aqueous solutions of sulphuric and phosphoric acids at 77°K by electron spin resonance and optical spectroscopy are described. Besides hydrogen atoms, the following radicals are formed in these systems: SO_4^- radical anions and OH radicals in sulphuric acid solutions; PO_4^{2-} radical anion and OH radical in phosphoric acid solutions. In concentrated solutions of acids the radicals SO_3^- and PO_3^{2-} are also formed. The yields of radicals were measured in relation to the concentration of the acids. The possible mechanism of radical formation is discussed. Photo- and thermal stability of free radicals were studied. Photochemical bleaching of radical anions obeys a first-order law. Reversible photo- and thermal transformations of radical anions and OH radicals were confirmed. (auth)

51536 EFFECT OF LINEAR ENERGY TRANSFER ON YIELDS AND SPATIAL DISTRIBUTION OF FREE RADICALS IN FROZEN AQUEOUS SOLUTIONS OF FREE RADICALS AT 77°K. Chernova, G. P.; Ershov, B. G.; Vladimorova, M. V.; Pikaev, A. K. Inst. of Physical Chemistry, Moscow). Int. J. Radiat. Phys. Chem.; 3: No. 2, 85-96(Aug 1971). (In Russian).

With ^{60}Co γ rays and ^{210}Po α particles as examples the effect of linear energy transfer was studied on accumulation, yields, and spatial distribution of free radicals in glassy 5 mol dm^{-3} aqueous solutions of $HClO_4$ and H_2SO_4 and in glassy 10 mol dm^{-3} aqueous solution of KOH at 77°K. In both cases the same free radicals were formed (H and OH in $HClO_4$ solution; H, OH, and SO_4^- in H_2SO_4 solution; e_{tr}^-, O^- and H in KOH solution). Compared to γ radiolysis the initial yields of free radicals (especially for alkaline "glass") decreased appreciably on α radiolysis. The spatial distribution of H atoms in acid solutions at low doses was nonuniform in the case of α radiolysis and uniform in the case of γ radiolysis. At high doses (≥3 × 10^{20} eV/cm^3) the distribution was uniform. In alkaline "glass" the distribution was nonuniform for both types of radiation. The effects obtained are explained on the basis of the radical diffusion model in water radiolysis. The radii of cylindrical tracks of α particles in acid solutions are equal to ≈80 to 100 Å for 5 mol dm^{-3} solution of $HClO_4$ and ≈45 to 90 Å for 5 mol dm^{-3} solution of H_2SO_4. (auth)

51537 PULSE RADIOLYSIS OF DIMETHYL SULPHOXIDE. Koulkes-Pujo, A. M.; Gilles, L.; Lesigne, B.; Sutton, J. (CEN de Saclay, Gif-sur-Yvette, France). J. Chem. Soc., D; No. 14, 749-50(21 Jul 1971).

Three absorptions associated with the electron (925 nm), the positive ion (625 nm), and an unidentified species (300 nm) were observed on pulse radiolysis of dimethyl sulphoxide. (auth) (UK)

Radioisotope Production

51538 ELECTROLYSIS OF CARRIER-FREE OSMIUM ISOTOPES AND A NOVEL METHOD FOR THEIR CONCENTRATION. Molnar, Jozsef; Molnar, Iren. Acta Chim. Acad. Sci. Hung.; 68: No. 3, 245-51(1971). (In Russian).

A method for the concentration of carrier-free osmium isotopes to a small volume was developed. The dependence of the electrolytic precipitation of these isotopes on the composition of the electrolyte, on current density, and on the time of electrolysis was investigated. On the basis of experimental results methods were developed, by means of which radiation sources of osmium isotopes with a neutron deficit are prepared for nuclear spectroscopic measurements. (auth)

51539 ELECTROLYSIS OF CARRIER-FREE IRIDIUM AND PLATINUM ISOTOPES. Molnar, Jozsef; Molnar, Iren. Acta Chim. Acad. Sci. Hung.; 68: No. 3, 237-44(1971). (In Russian).

The dependence of the electrolytic precipitation of carrier-free iridium and platinum isotopes on the composition of the electrolyte and on other factors was investigated. On the basis of experimental results, methods were developed by means of which the radiation sources of iridium and platinum isotopes with a neutron deficit are prepared for nuclear spectroscopic measurements. (auth)

Recoil Production and Reactions

51540 ABIOLOGICAL SYNTHESIS OF ADENOSINE 2′-, 3′-, AND 5′-MONOPHOSPHATES USING RECOILED ^{31}P ATOMS OBTAINED FROM THE β-DECAY OF ^{31}Si. Akaboshi, Mitsuhiko; Kawai, Kenichi; Waki, Asako (Kyoto Univ.). Biochim. Biophys. Acta; 238: No. 1, 5-7(Apr 1971).

30 mg of ^{30}Si (70 to 90% enriched $^{30}SiO_2$) were irradiated in a hydraulic conveyer of Kyoto University Reactor for 10 hr (thermal neutron flux, approximately 8.0 × 10^{13} neutrons/cm^2 per sec). Immediately after irradiation, 0.5 μC of [^{14}C]adenosine was added, and all the ^{31}Si was allowed to decay for 2 to 3 days at room temperature. Paper chromatography and radioautography showed that about 2% of the adenosine was converted to AMP (approximately 1% 5′-AMP, approximately 0.5% 2′-AMP, approximately 0.5% 3′-AMP). It is supposed that an identical reaction took place in the primordial earth and might have played an important role in the origin of life. (auth)

51541 ANNEALING REACTIONS IN POTASSIUM CHROMATE. PART 2. EFFECTS OF OXYGEN. Ackerhalt, R. E.; Collins, C. H.; Collins, K. E. (Univ. of New York, Buffalo. Western New York Nuclear Research Center, Buffalo). Trans. Faraday Soc.; 67: No. 581, 1459-66(May 1971).

Isothermal and isochronal annealing of neutron-activated K_2CrO_4 were carried out in the presence and in the absence of oxygen. The ^{51}Cr(VI)-retention is unaffected by the presence of oxygen, as previously reported. The ^{51}Cr(III) distribution between ^{51}Cr(III)-monomer and ^{51}Cr(III)-dimer + polymer is insensitive to oxygen at annealing temperatures below 100°C but is affected by the presence of oxygen above 100°C. Experiments with post-irradiation-recrystallized K_2CrO_4 show a similar effect of oxygen upon the distribution of ^{51}Cr among the ^{51}Cr(III) species after annealing at temperatures greater than 100°C. It is proposed that crystal defects, trapped charge carriers and other species introduced by radiation do not play an essential role in the annealing reactions which occur above 100°C. Oxygen may directly affect the crystal-phase ^{51}Cr(III)-precursor species, rather than act solely as a surface electron trap. (auth) (UK)

51542 LOCALIZATION OF A RADIOACTIVE BROMINE ATOM IN A 1,2-DIBROMOALKANE. Ronneau, C.; Cara, J.; Apers, D. J.;

Capron, P. C. (Univ., Louvain, Belg.). Radiochem. Radioanal. Lett.; 7: No. 1, 67-9(15 Jun 1971).

Hydrogen bromide elimination followed by a gas chromatographic analysis locates a tagged bromine atom, which has been inserted in a n-bromoalkane to form a 1,2-dibromoalkane. This method appears to be useful in the study of photobromination of n-butyl bromide and of the reactions induced by recoil Br atoms as a consequence of thermal neutron capture in n-butyl bromide. (auth)

Radiochemistry

Refer also to abstracts 51384, 51385, 51401, and 53748.

51543 (NAS-NS-3018(Rev.)) RADIOCHEMISTRY OF MANGANESE. Schuman, R. P. (Robert Coll., Istanbul (Turkey)). Jul 1971. 67p. Dep. NTIS.

Nuclear Science Series of National Academy of Sciences–National Research Council, Washington, D. C. Committee on Nuclear Science.

General reviews on the inorganic, analytical, and radiochemistry of manganese are given. The radioactive nuclides of manganese, the chemistry of manganese, hazards and precautions, counting techniques, and separation procedures are discussed. (103 references). (M.C.G.)

51544 (NYO–4177-103) RESEARCH IN NUCLEAR CHEMISTRY. Annual Report. Kaplan, Morton (Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Chemistry). Jul 1971. Contract AT(30-1)-4177. 41p. Dep. NTIS.

Progress is reported on: Moessbauer studies of $FeCl_3 \cdot 6H_2O$, research on Moessbauer spectra of Fe^{3+}: ice, determination of the field dependence of internal field and alignment angle in Fe metal at 4.2°K, Moessbauer effect hyperfine studies of $Eu(NH_3)_6$, hyperfine studies of europium hexaboride, system for measurement of short nuclear lifetimes and γ-γ angular correlations, and application of perturbed angular correlation experiments to the study of molecular motion in solution. (M.C.G.)

51545 (Y-CDC–9) CRITICALITY OF LIQUID MIXTURES OF HIGHLY ^{235}U-ENRICHED URANIUM HEXAFLUORIDE AND HYDROFLUORIC ACID. Caizergues, Robert; Deilgat, Edouard; Lecorche, Pierre; Maubert, Louis; Revol, Henri (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1968. 78p. Dep. NTIS.

The criticality of spherical and near-spherical volumes of liquefied UF_6–HF mixtures, in which the uranium was enriched to 93% in ^{235}U, in Monel containers having 4-mm-thick walls and surrounded by an effectively infinitely thick water reflector, was investigated. The hydrogen-to-uranium atomic ratio of the mixture ranged between zero and eighty, the latter corresponding to a composition of about 1.23 mole% UF_6. The temperature of the mixture during the experiment was between 70 and 95°C. Short extrapolations utilizing measured and calculated reflector, temperature, dimensional, and structural-material coefficients of reactivity and neutron multiplication data established the critical dimensions of spheres of the several compositions. It was observed, for example, that the critical mass of unmoderated UF_6 is greater than 165 kg of uranium and that the critical spherical diameter of UF_6–HF is greater than 450 mm over the range of concentrations explored. Critical masses as low as 8.8 kg of uranium were observed. Monte Carlo and neutron transport theory calculations gave values of the effective neutron multiplication factor in reasonably good agreement with experiment. (auth)

51546 STABILITY OF PLUTONIUM SULPHATE TETRAHYDRATE, AN ANALYTICAL STANDARD: A TEN-YEAR EVALUATION. Pietri, Charles E.; Wenzel, Albert W. (New Brunswick Lab., N. J.). Talanta; 18: No. 8, 849-52(Aug 1971).

The stability of plutonium sulphate tetrahydrate, $Pu(SO_4)_2 \cdot 4H_2O$, an analytical standard for plutonium, was studied over periods of up to 10 years, and at relative humidities of 95% and less than 0.1%. The material was found to be stable with time; it was slightly affected by extremes of humidity but the changes were readily reversible. (auth) (UK)

51547 SEPARATION OF THE DECAY PRODUCTS OF A ^{224}Ra SOURCE AS METHYL COMPOUNDS. Hoffmann, P.; Bachmann, K.; Klenk, H.; Lieser, K. H. (Technische Hochschule, Darmstadt, Ger.). Inorg. Nucl. Chem. Lett.; 7: No. 7, 577-82(Jul 1971). (In German).

Decay products enter the gas phase by recoil and are then entrained by a flow of hydrogen, tetramethyllead, or methyl radicals from thermal decomposition of the latter. This is followed by cold trapping and identification by scintillation spectrometry. (UK)

Separation Processes

Refer also to abstracts 51422, 51465, 51543, 51545, 51638, 51640, 51641, 51700, 51701, 51774, 51781, 52060, 52420, and 53923.

51548 (A/CONF.49/P–28) OPERATING EXPERIENCE AND PLANNED IMPROVEMENTS IN THE EUROCHEMIC REPROCESSING PLANT. Joseph, C. J.; Detilleux, E.; Centeno, J.; (and others) (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). May 1971. 23p. (CONF-710901–75). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A short description of the Eurochemic Reprocessing Plant is given. From the active start-up in 1966, 48t natural U metal canned in Al or Mg, 48t natural or slightly enriched UO_2 canned in Zircaloy, stainless steel, or Al with a maximum burn-up of 26,000 MWd/t, and 8t highly enriched U–Al alloy with a maximum burn-up of 50% are reprocessed. The total amounts of fissile material recovered were 173 kg Pu and 330 kg highly enriched U. The operating experience is briefly summarized. Anticipated changes in the installation are outlined. Equipment, flow sheets, etc., for these improvements are given. A new Pu cycle based on a concentration by solvent, an Am removal step to cope with higher burn-ups, and a planned Np recovery unit are discussed. A cost analysis of the new installation and an economic evaluation of equipment safe by geometry or heterogeneous poisoning are presented. (auth)

51549 (A/CONF.49/P–182) ITALIAN PROGRESS REPORT ON REPROCESSING OF IRRADIATED FUEL. PART I. THE EUREX PILOT PLANT. PART II. THE ITREC PILOT PLANT. Calleri, G.; Cao, S.; Fiorelli, M. (CNEN, Vercelli, Italy); Orsenigo, G.; (and others) (CNEN, Matera, Italy). May 1971. 24p. (CONF-710901–188). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The EUREX pilot plant, started up in October, 1970, was designed for industrial-scale research in the field of reprocessing of natural uranium or enriched uranium fuel elements, both with high and low enrichment. The capacity of the plant is 30 kg U–Al alloy/d using MTR type elements; in the case of natural uranium or low enriched uranium elements, the capacity is 100 kg/d. A brief description of the plant is given and the main characteristics of plant design and construction, such as safety criteria, transfer procedure, instrumentation, process control, and maintenance system, are discussed. Results of the first runs of the plant are reported. The reprocessing of MTR elements is performed using as an extracting agent a tertiary amine, tricaprylamine, in place of tributyl phosphate. The ITREC pilot plant was designed for integrated experiments of reprocessing, with partial decontamination, and remote refabrication of fuels. The plant now in phase of start-up has a reference capacity of 15 kg/day of thorium and uranium and will reprocess on its first run the ThO_2–UO_2 Elk River Reactor fuel. The recovered ThC_2–UO_2 will be used to constitute elements for the irradiation of the Halden reactor. The principal characteristics of the plant are outlined with particular emphasis on the process and maintenance methods. Information and data from the process qualification runs are illustrated and discussed with reference to the process yield, product specification, and equipment performance. The research and development program for the future utilization of the ITREC plant is briefly described. (auth)

51550 (A/CONF.49/P–211) ION EXCHANGE APPARATUS FOR AUTOMATIC SEPARATION OF URANIUM FISSION PRODUCTS FOR ANALYTICAL PROCESS CONTROL AND TECHNICAL PROCESSES. Bobleter, O.; Forster, H. P.; Reuschel, A. G. (Oesterreichische Hochschule, Vienna. Atominstitut). May 1971. 12p. (CONF-710901–158). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A fully automatic analysis apparatus was developed for the analytical determination of the elements of uranium fission product solutions. Ion exchange chromatography is used to separate the uranium fission product solutions into their individual elements. A time programming switchboard operates electromagnetic valves in a previously determined order. By this means the solution to be analyzed can be applied to the ion exchangers and eluting media separate the mixtures into their individual elements. This apparatus also includes equipment for the automatic registration of the activity emitted by the elements. In this way, for example, a solution of U, Zr, Nb, Mo, Tc, Cs, Sr, Y, and Ce was automatically separated into the groups (U), (Zr, Nb, Mo, Tc), and (Cs, Sr, Y, Ce), and from these groups the individual elements

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were isolated by a step-wise elution with mineral acids. The application of this automatic ion exchange separation method in technical fission product processes is discussed. (auth)

51551 (A/CONF.49/P–239) AQUEOUS REPROCESSING TEST WITH IRRADIATED FUELS. Ishihara, Takehiko; Aochi, Tetsuo (Japan Atomic Energy Research Inst., Tokai). May 1971. 23p. (CONF-710901–94). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Since 1959 the Japan Atomic Energy Research Institute (JAERI) has been promoting a project to design and construct an aqueous reprocessing test plant that would contribute to the establishment of Japanese reprocessing technology. A description of the reprocessing test plant (PNC) as well as the accumulated operating experience and results obtained through hot tests are summarized. The results of certain developments are also given on such process equipment as a volumetric air-lift for small flow rate and an air pulsator, etc., and on such related chemical problems as determination of burn-up, process behavior of iodine, improvement of the decontamination factor, effective stripping of plutonium, and a preliminary attempt at computer evaluation. After the hot operation tests, training of the PNC employees was continued at the test plant. Process studies also have been started to reprocess the fuel, which will be discharged from an experimental fast breeder reactor (Joyo) in the PNC plant. (auth)

51552 (A/CONF.49/P–378) AN ASSESSMENT OF THE DEMAND FOR AND THE SUPPLY OF NUCLEAR FUEL AND FUEL/CYCLE SERVICES IN THE FRG. Eitz, A. W. (Gesellschaft fuer Kernforschung m.b.H., Karksruhe (West Germany)); Finnemann, H.; Maerkl, H.; (and others) (Siemens A.G., Erlangen (West Germany)). Apr 1971. 15p. (CONF-710901–131). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A system analysis of the development of nuclear energy was carried out for the Federal Republic of Germany (FRG). This resulted in estimates of nuclear fuel and separative work demand, plutonium production, and reprocessing capacities in the fuel cycle. Ways of economically meeting the respective requirements are given. In the seventies, mainly nuclear power stations with light water reactors will be used. Hence, the variations in nuclear fuel demand and in separative work and reprocessing capacities can be assessed with sufficient accuracy for the initial phase. After 1980, the increase in nuclear generating capacity and the reactor lines in use will have a special nonlinear influence on demand within the fuel cycle. Sensitivity analyses assess the significance of the times of commercial introduction of advanced types of reactors and their use in the load diagram. Assuring the long-term supply of uranium concentrate is among the activities of German industries together with national companies abroad. (auth)

51553 (A/CONF.49/P–381) START-UP EXPERIENCE WITH THE KARLSRUHE REPROCESSING PLANT AND LONG-RANGE FUEL REPROCESSING DEVELOPMENT OBJECTIVES IN THE FEDERAL REPUBLIC OF GERMANY. Schueller, W.; Baumgaertner, F.; Krause, H.; Dyroff, H. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). Apr 1971. 20p. (CONF-710901–133). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

An account is given of experience gained during initial operation of the first German prototype reprocessing plant (WAK) at the Karlsruhe Nuclear Research Center. In order to supplement plant experience and to advance reprocessing technology, a long-range reprocessing development program was initiated 4 years ago in close collaboration between the Karlsruhe Center and industry. The principal objective of this program is to improve reprocessing methods, i.e., by use of high-performance centrifugal contactors and in-line process automation, and to adapt aqueous techniques to the treatment of fast breeder fuels. In view of the increasing concern for environment protection, particular attention is given to the treatment of gaseous and liquid radioactive effluents. The most significant project in this context will be the construction of a prototype fission product vitrification plant with a capacity of 150 MCi/a. This facility will serve the WAK and is scheduled for hot operation in 1974. In addition the Karlsruhe development program includes the recovery of neptunium and transplutonium elements as source material for the production of isotopic generators (^{238}Pu and ^{244}Cm) or neutron sources (^{252}Cf). (auth)

51554 (A/CONF.49/P–427) OPERATION EXPERIENCE OF AUTOMATIZED PILOT INSTALLATION FOR TREATMENT OF EFFLUENTS BY ELECTRODIALYSIS METHOD. Rausen, F. V.; Kuleshov, N. F.; Smolkin, I. M.; Trofimov, D. I.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 22p. (CONF-710901–377). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Design features and the automatic control scheme of an electrolysis facility having a capacity of 100 m^3/d are discussed. Results of the pilot plant operation during the three-month startup period are presented. The facility consists of two electrodialysis apparatuses, each of them having 500 chambers. The desalination chambers of the second apparatus are loaded with a mixture of ion exchange resins. Waste solution successively passes through both apparatuses and at the outlet is converted into pure water. After decontamination of radioactive solutions at the facility the only waste is the concentrate forming in salt liquor chambers of the first apparatus. The volume of the concentrate is less than 1% of that of the decontaminated effluents. (auth)

51555 (A/CONF.49/P–435) AQUEOUS PROCESSING OF POWER REACTOR FUELS. Shevchenko, V. B.; Khonickevich, A. A.; Renard, E. V.; Smelov, V. S.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 26p. (CONF-710901–381). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Thermal reactor fuel elements are cooled for a year, and processed in a plant using a three-cycle extraction flow sheet. Chopped fuel is dissolved in a batch-type vessel with air-lift removal of insoluble swarf. A melting method looks promising for removal of stainless steel and zirconium cladding. The extraction processing of fuel elements is attended with a formation of interfacial suspensions which heavily complicate the process. The initial solution is therefore heated with a flocculator and then filtered. Extraction with 30% TBP in sulfurated synthin is performed in geometrically safe pulsed mixer-settlers. After cooling over a six-month period, fuel elements from converter reactors, as well as those from breeders (in the initial stage of operation), are processed in facilities using a preliminary dilution before extraction cycles to attain the activity level comparable to that of the solutions resulting from dissolving thermal reactor fuel elements. Reprocessing of fuel elements may follow various flow sheets depending on a fuel fabrication method. When a co-precipitation method is used, the process flow sheet does not involve separation of uranium from plutonium. In the case of the mechanical mixing of oxides and the sol-gel process, plutonium is recovered in the first extraction cycle and additionally treated with amines. Much attention in the reprocessing of fast reactor fuels is given to the behavior of I, ^{3}H, and ^{85}Kr. Costs of chemical reprocessing of irradiated fuels may be somewhat reduced through recovery of neptunium, americium, curium, strontium, and some other elements. (auth)

51556 (A/CONF.49/P–443) EXTRACTION OF URANIUM AND PLUTONIUM USING MONO- AND BIFUNCTIONAL PHOSPHINE OXIDES. Laskorin, B. N.; Skorovarov, D. I.; Shatalov, V. V.; Filippov, E. A.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, [Moscow]). Jun 1971. 19p. (CONF-710901–356). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Studies on metal extraction by aliphatic and aromatic tertiary phosphine oxides are reviewed. The investigation of the structure of phosphine oxide radicals and to the choice of solvent is discussed. The solubility of substituted phosphine oxide complexes with uranium and plutonium in organic solvents was studied. Secondary aliphatic radicals of phosphine oxides were found to increase the solubility of the complexes of both metals in paraffin hydrocarbons. Uranium and plutonium were extracted from the solutions prepared by the dissolution of the irradiated uranium targets. (auth)

51557 (A/CONF.49/P–448) BASIC PROBLEMS OF FLUORINATION METHOD FOR FAST POWER REACTOR FUEL REPROCESSING. Veryatin, U. D.; Galkin, N. P.; Zooev, V. A.; Lomov, V. I.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, [Moscow]). Jun 1971. 28p. (CONF-710901–280). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Research carried out in the USSR on the development of non-aqueous methods for the processing of irradiated oxide fuels for fast reactors is reviewed. The main efforts are aimed at the development of irradiated fuel processing fluorine method. Electrochemical methods are also considered. Fluorine method development includes research on the following process stages: cladding removal, fuel fluorinating, separation of hexafluorides of actinides, U and Pu separation from fission products, and production of uranium and plutonium oxides suitable for nuclear fuel fabrication. Stainless steel melting at the temperature more than 1400°C was studied as one of the methods to remove cladding. U and Pu oxides are separated from stainless steel melt by filtration. Incorporation of UO_2 into steel ingot is from 1×10^{-2} to 5×10^{-2} wt %, and that of PuO_2 is 8×10^{-3} wt %. Less than 0.5% of steel was found in the fuel. The results of laboratory research on the kinetics and mechanism of the fluorination of U and Pu oxides with fluorine and halogen fluorides are given. The process of fluorination of oxides in a compact and boiling layer was studied. A thermal decomposition method was studied for U and Pu hexafluoride separation. It was also found, that it is possible to obtain high refinement coefficients ($>10^7$) by use of a combination of sorption and rectification at UF_6 refinement from fission products. Physical and chemical foundations of fuel element electrochemical regeneration methods were considered. (auth)

51558 (A/CONF.49/P–459) UNDERGROUND LEACHING OF URANIUM ORES. Zefirov, A. P.; Nevskii, B. V.; Bakhurov, V. G.; Lutsenko, I. K.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, [Moscow]). Jun 1971. 22p. (CONF-710901–358). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Underground leaching of uranium is a process based on selective dissolution of uranium by a chemical agent in the place of the ore deposit. The uranium-containing solutions are supplied to the surface, then returned to the leaching process after extraction of the uranium. The advantages of underground leaching as compared with those of mechanical mining are discussed. Flow sheets have been developed for the recovery of U from massive rocks and from bedded sedimentary deposits. (J.G.B.)

51559 (A/CONF.49/P–491) DEVELOPMENT, DESIGN, AND OPERATION OF THE OXIDE FUEL REPROCESSING PLANT AT THE WINDSCALE WORKS OF BRITISH NUCLEAR FUELS LIMITED. Hughes, T. G.; Warner, B. F. (British Nuclear Fuels Ltd., Sellafield (England)); Corns, H.; (and others) (British Nuclear Fuels Ltd., Risley (England)). May 1971. 8p. (CONF-710901–153). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The adaptation of the First Separation Plant at Windscale to the processing of enriched oxide fuels from thermal reactors is described. The principles of the fuel receipt, transfer system, and shear-leach cell are outlined. The first cycle butex solvent process and the TBP process used further to purify the products in the Second Separation Plant are described with particular reference to the methods used to achieve safe and flexible operation. The problems met in this adaptation and the solutions used are illustrated by reference to salient aspects of the development work, the design concepts and operational experience. (auth)

51560 (A/CONF.49/P–492) OPERATING EXPERIENCE WITH THE UNITED KINGDOM FUEL REPROCESSING PLANTS AT WINDSCALE AND DOUNREAY. Boyle, J. G.; Hutchins, P. A.; Pritchard, E. H.; Rankin, G. S.; (and others) (British Nuclear Fuels Ltd., Windscale, Eng.). Jun 1971. 10p. (CONF-710901–290). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The main features of operating experience for the Dounreay Chemical Plants and the New Separation Plant at Windscale are described. Head End processes, fuel dissolution, and solvent extraction details for both plants are outlined together with a description of high-level waste evaporation and storage and acid recovery from medium active liquor streams arising in the larger Windscale plant. Engineering maintenance problems and their solutions are discussed for both plants. Plant control and instrumentation is described. The performance of the Dounreay integrated processing plant for MTR–DRF fuel is presented. Preliminary results are given of unirradiated PuO_2–UO_2 reprocessing based on computer calculations using the Simtex code. (auth)

51561 (A/CONF.49/P–522) URANIUM INDUSTRY AND NUCLEAR FUEL REQUIREMENTS FORECAST IN PORTUGAL. Cabral, J. M. P.; Pich, H. C.; Vicente, C. M. (Junta de Energia Nuclear, Lisbon (Portugal)). May 1971. 16p. (CONF-710901–230). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Studies undertaken by Junta de Energia Nuclear on uranium leaching, solvent extraction, nuclear grade purification, and metallurgy, as well as the present status and perspectives of the uranium mineral industry in Portugal, are reviewed. Data on Portuguese uranium resources and demand up to the year 2000, considering light water and fast breeder reactors, are compared. Perspectives of nuclear fuel cycle services involved, particularly enrichment, fuel fabrication, and reprocessing, are also discussed. (auth)

51562 (A/CONF.49/P–601) ADAPTING FRENCH REPROCESSING PLANTS TO NEW TYPES OF IRRADIATED FUELS. Auchapt, P.; Chambon, M.; Couture, J.; Duboz, J.; (and others) (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jul 1971. 13p. (CONF-710901–403). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The La Hague fuel reprocessing plant is now under modification to allow the reprocessing of light water reactor fuels by 1975, as well as of breeder fuels. These modifications include a new chop and leach unit. Problems raised by increasing radioactivity, and by high concentration of fissile materials, required technological modifications in existing facilities. At the Marcoule fuel reprocessing plant, successive technical improvements made during recent years allow the reprocessing of graphite–gas-type power reactor fuels. Some modifications also allow the reprocessing of highly enriched fuels. These adaptations will enable Marcoule to reprocess MTR type reactor fuels. These technical modifications, involving very low investments compared to the cost of the whole plants, will enable French plants to reprocess fuels from gas–graphite, light water, fast neutron, and research reactors. (auth)

51563 (A/CONF.49/P–603) PROCESSING OF HIGHLY IRRADIATED FUELS, TECHNICAL SITUATION AND FUTURE PROSPECTS PUREX PROCESS, DRY PROCESS. Faugeras, P.; Bourgesois, M.; Talmont, X.; (and others) (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1971. 16p. (In French). (CONF-710901–249). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Problems arising at La Hague facility AT.1 from the processing of fuels from the experimental reactor Rapsodie are reviewed. Characteristics of that facility and of the ATTILA unit are outlined. Experience acquired during the testing of the ATTILA unit for processing alloy type fuels (U–Zr and U–Al) and mixed oxides UO_2–PuO_2 for breeder reactors is summarized. The results of research on investments and reprocessing costs for the two methods are reported, taking into account technical progress and foreseeable savings. (J.G.B.)

51564 (A/CONF.49/P–621) PROGRESS IN THE EFFLUENT PROCESSING AND CONDITIONING TECHNIQUES IN RESEARCH CENTRES. Pottier, P. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires); Andriot, R. (Commissariat a l'Energie Atomique, Valduc (France). Centre d'Etudes); Cuaz, D. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr 1971. 16p. (In French). (CONF-710901–255). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Recent progress in the specific treatments of certain radioelements and the conditioning of evaporation concentrates is reviewed. Research aimed at the improvement of effluent decontamination has led to the development of specific treatments. The use of preformed precipitates of nickel ferrocyanide reduces the reagent consumption by a factor of up to 10 without changing the cesium-137 decontamination level. The use of iron compounds, activated by various additives, improves the ruthenium-103 and 106 decontamination by a factor of 4 to 10. The use of carboxyl group ion exchangers leads to an appreciable improvement of the strontium-90 decontamination in highly saline solutions. The use of a pulsed-air evaporator provides better conditions of tritium discharge by dispersion in the atmosphere. Progress has been made in the field of conditioning and solidification of evaporator concentrates. At the Valduc Centre the use of vertical thin-layer evaporators using crude distilled bitumen to embed concentrates containing α emitters has been applied industrially. The first working results are given, together with a discussion on the difficulties encountered and the remedies found. At the Cadarache Centre a nonvoluminous horizontal thin-layer evaporator has been developed. It uses bitumen emulsions and is particularly suitable for the conditioning of concentrates of variable composition. At the Grenoble Centre, in order to reduce the volume of wastes stored at present after mixing with cement, studies are being carried out on the desiccation of evaporation concentrates in a rotating-cylinder secondary evaporator and their cold embedding in a polymer that hardens under the action of heat. (auth)

XUM

51565 (A/CONF.49/P–640) DEMANDS FOR REPROCESSING SERVICES AND THE PLANNING OF INDUSTRIAL REPROCESSING FACILITIES IN WESTERN EUROPE. Marcus, F. R.; Seynaeve, F. May 1971. 11p. (CONF-710901–305). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The reprocessing market in Western Europe is reviewed on the basis of recent plans for nuclear power installations. Requirements up to 1978 are given for different fuel types. Amounts of irradiated fuel needing reprocessing up to 1988 are also estimated. Amounts of metal fuel from gas-cooled reactors will remain essentially constant, while there will be a rapid increase in irradiated oxide fuel, especially in countries like Western Germany, the United Kingdom, Spain, Italy, and Sweden. In 1980 the daily total reprocessing load of oxide fuel will amount to approximately 5 tons. The quantities of plutonium to be separated and of waste concentrates created are also calculated. A survey of existing and planned reprocessing plants and their capacity for different types of fuel is presented. Comparison with the reprocessing load shows that a surplus of plant capacity is likely to exist in Western Europe throughout the next decade. The role of reprocessing in the nuclear fuel cycle and its importance in controlling the environmental consequences of nuclear energy generation are emphasized. (auth)

51566 (A/CONF.49/P–650) AQUEOUS REPROCESSING OF Th–^{233}U FUEL CYCLE BY AMINE SOLVENT FROM SULPHATE MEDIA. Awwal, M. A. (Atomic Energy Centre, Dacca (Pakistan)). Jun 1971. 25p. (CONF-710901–477). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Detailed studies on the processing of irradiated thorium using an amine solvent on a pilot plant scale are reported. The extraction of one-year-old gross fission products was investigated with methyldidecylamine, a tertiary amine. A solution of 0.1M methyldidecylamine in xylene showed only slight extraction of cerium-144, ruthenium-106, and limited extraction of zirconium-95 when the aqueous phase acid concentration is 0.005N H_2SO_4. Higher aqueous sulfuric acid concentration gave lower extraction of cerium-144 and ruthenium-106, whereas the extraction of zirconium-95 was slightly increased. The effect of aqueous sulfate ion concentration on the extraction of mixed fission products indicated that the extraction of cerium-144 and ruthenium-106 decreases with the increasing aqueous sulfate ion concentration, but the extraction of zirconium-95 remains unchanged. Extractions of individual fission products, zirconium-95, cerium-144, and ruthenium-106, with 0.1M amine were studied in detail. The partition coefficient of zirconium-95 decreased from 27.5 to 0.1 with the variation of aqueous acid concentration from 5×10^{-3} to 10N H_2SO_4. With the variation of aqueous sulfate ion concentration from 5×10^{-3} to 1M Na_2SO_4, the partition coefficient decreased from 23.5 to 8.6. Similar studies with ruthenium-106 were carried out. The partition coefficient of 0.6 was obtained at 5×10^{-3}N H_2SO_4. It increased to 4.2 at 0.5N H_2SO_4 and then decreased to 0.4 at an acid concentration of 10N H_2SO_4. The effect of aqueous sulfate ion concentration on the partition coefficient of ruthenium-106 was less pronounced than that of acid. Cerium-144 gave a very low partition coefficient value of 4×10^{-2} at 5×10^{-3}N H_2SO_4. It decreased further to 9×10^{-3} at 0.5N H_2SO_4. The effect of sulfate ion concentration of the partition coefficient of cerium-144 is insignificant. Sulfuric acid was selected as a stripping agent for thorium and nitric acid for uranium. The chemical flowsheet for the processing of irradiated thorium for the separation of uranium-233 and thorium is discussed. The uranium-233 and thorium are coextracted with 0.1M methyldidecylamine from a feed solution of 5.8 g Th/l having a sulfuric acid concentration of 5×10^{-3}N H_2SO_4. The extracted thorium is selectively stripped with 1N H_2SO_4 and uranium-233 is stripped with 0.5N HNO_3. The final product is purified by anion exchange. The decontamination factor from fission products for uranium-233 is 3.2×10^4, and for thorium it is 3.8×10^4 for the single cycle solvent extraction process. The separation factor of uranium-233 from thorium was found to be 2×10^4. (auth)

51567 (A/CONF.49/P–670) SOME ASPECTS OF THE NUCLEAR FUEL CYCLE AND THEIR RELATIONSHIP TO THE PRODUCTION OF RAW MATERIAL. Young, S. A. (Nuclear Fuels Corp. of South Africa (Pty) Ltd., Johannesburg). May 1971. 10p. (CONF-710901–316). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The nuclear fuel cycle is examined from the standpoint of the supplier of uranium feed materials. The various processes in a fuel cycle route, such as the initial conversion into uranium fluoride, enrichment, fuel manufacture, and the burning of fuel in the reactor and reprocessing, all have aspects that must be noted by the raw material producer who wishes to offer his product in the most suitable qualities and quantities, and for delivery at the most suitable time, to his customers. For example, the quality of the product is closely related to the process to be used for enrichment, and the feed material specifications that may apply are discussed in relation to the feasibility of production and the availability of appropriate methods of analysis. The quantities of the product to be offered for delivery are dependent not only on the type and method of operation of the reactor installation for which they are required, but also on earlier stages in the fuel cycle such as the feed requirements for the enrichment process, and on later stages such as the separation and recycling of plutonium. These features are discussed in relation to the raw material supplier's plans for production and delivery. The most suitable time for the production of different forms of uranium is considered in relation to the changing pattern of requirements brought about by the fuel cycle policies in different countries. The steps taken by current South African producers to ensure that their Nuclear Fuels Corporation is able to offer secure supplies of uranium, in the manner and form most suited to the needs of its customers, is described with particular reference to new developments which recognize the market trends in the future and the possible variation in the fuel cycle pattern adopted by electrical power station operators throughout the world. (auth)

51568 (A/CONF.49/P–689) METHODS FOR SEPARATION AND REFINING OF TRANSURANIUM ELEMENTS. Zaitsev, A. A.; Karelin, E. A.; Kosyakov, V. N.; Lebedev, I. A.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). Apr 1971. 20p. (In Russian). (CONF-710901–495). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Complexing of transplutonium elements with complexing agents containing the functional groups P = 0 and P = 0 – OH and associated with other functional groups and complexons of polyaminopolycarbonic series was studied using ion exchange, extraction, electromigration methods, potentiometry, and spectrophotometry. Results of investigations on the extraction of the transplutonium elements and some fission products with organophosphorus compounds and alkylamines are presented. The effect of the concentration of an extracting agent, a complexon, hydrogen ions, and temperature on the extraction of the transplutonium elements and some other fission products from the solutions of mineral and carbonic acids was studied. Experimental data on the kinetics of oxidation-reduction reactions of uranium, neptunium, and plutonium show the absence of the essential contribution of Coulomb interaction to the free energies of activation, and this can be explained by assuming the mechanism of charge transfer for a long distance with the solvent molecules taking part in this process. Correlation of the thermodynamic and crystallographic characteristics of metals and actinide halides was established. The established regularity of the sublimation constants and the lattice parameters changes is explained by their general dependence on the structure and order of electron shell filling. (auth)

51569 (A/CONF.49/P–703) REMOVAL OF RADIOIODINE FROM GASES. Nakhutin, I. E.; Smirnova, N. M.; Makarov, V. M.; Loshakov, G. A.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, [Moscow]). Jun 1971. 28p. (CONF-710901–362). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Investigations of iodine in solutions resulting from the dissolution of fuel elements have shown that ICN is present in the solutions together with I_2 and IO_3^-. Being a volatile compound, ICN also occurs in the gases released in the fuel dissolution. To remove iodine released from the gaseous phase in the presence of nitrogen oxides, a method of isotopic exchange with AgI was developed. The method gives high factors of the gas decontamination from iodine and its compounds and has an advantage over the other methods as AgI is insoluble in water. Activated charcoal is the most effective adsorbent when aggressive gases are not present. Adsorption coefficients were measured for molecular iodine on activated charcoal under various conditions. Some data were obtained on the adsorption kinetics. Sorption equilibrium was not achieved at low temperatures. Distribution of iodine in the columns with adsorption and simultaneous decay of radioactive iodine was determined. The column decontamination factor was increased by trapping alkyl iodides together with molecular iodine. (auth)

51570 (A/CONF.49/P–730) RECOVERY OF URANIUM FROM MARGINAL ORES. Josa, J. M.; Cordero, G.; Gasos, P.;

Gonzalez, E.; (and others) (Junta de Energia Nuclear, Madrid (Spain)). May 1971. 18p. (In Spanish). (CONF-710901-502). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Problems arising in the recovery of uranium from very low grade (500 ppM U_3O_8) monometallic ores, and from small and isolated mines whose grade is in a middle range (500 to 1500 ppM U_3O_8) are discussed. For the treatment of these ores a very simplified process was developed. The flowsheet has only heap leaching and solvent extraction of the pregnant liquors. The economy of the process for several types of ores (granitic, slatey, and clayed rocks) is discussed on the basis of Spanish studies and operations. The possibilities of recovering the uranium as a byproduct from other industries are also considered. A short outline of the last two years of research on uranium recovery from phosphoric acid and the planning of a commercial operation are given. The progress, in Spain, in recovering uranium from other minor sources (sandstones, coals, mine water, and copper liquors) is indicated. (auth)

51571 (AERE-R-6418) VOLATILISATION AND DEPOSITION OF RUTHENIUM DIOXIDE IN RELATION TO THE FINGAL PROCESS. Holdoway, M. J. (Atomic Energy Research Establishment, Harwell (England)). May 1971. 25p. Dep. NTIS (U. S. Sales Only). UK 23p.

The processes by which ruthenium is volatilized at high temperatures were studied with reference to the FINGAL process. The mechanism of ruthenium transport was explained by the formation of gaseous ruthenium trioxide and ruthenium tetroxide due to the presence of oxygen in the system at concentrations greater than the dissociation pressure of ruthenium dioxide. When oxygen was absent, or present at concentrations lower than the dissociation pressure of ruthenium dioxide, ruthenium dioxide was found to dissociate into its elements, and no ruthenium was lost by the system. The deposition of ruthenium dioxide, due to the instability of the gaseous higher oxides at lower temperatures, was studied by tracer methods using $^{105}RuO_2$ in controlled experiments designed to simulate conditions in the FINGAL equipment. (auth) (UK)

51572 (CONF-711001-(Vol.1), pp 294-305) SEPARATION OF SAMARIUM BY A SELECTIVE STRIPPING PROCEDURE. Bauer, D. J.; Schultze, L. E.; Lindstrom, R. E. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

A solvent extraction system employing selective stripping of a preloaded organic phase (DEHPA) was investigated for recovering Sm_2O_3 from a light-group rare earth mixture. The samarium concentrated in the organic phase, and a >99% pure samarium oxide product was obtained at 76% recovery in a 20-stage operation using di(2-ethylhexyl) phosphoric acid (EHPA) as the organic phase. The stripping agent was a 1.5% hydrochloric acid solution containing 200 g of ammonium chloride per liter. (auth)

51573 (DOCKET-408084-1) LISBON VALLEY URANIUM MILL. Environmental Report, Operating Licence Stage. (Rio Algom Corp., Moab, Utah). 31 Aug 1971. 109p. Dep. NTIS.

An environmental report is presented in support of an application to operate a uranium concentrator in San Juan County, Utah. The impact of the operation on the total environment is discussed and monitoring and control methods are described. Topics covered include: physical environment in the vicinity of the operation, the human environment at present, planned operations, disposal of wastes generated by the operation, environmental surveys to be conducted, human resources required, rehabilitation of the area, and environmental considerations. (M.C.G.)

51574 (DOCKET-408102-1) HIGHLAND URANIUM MILL, CONVERSE COUNTY, WYOMING. Applicant's Environmental Report. (Humble Oil and Refining Co., Houston, Tex. Minerals Dept.). Jul 1971. 145p. Dep. NTIS.

The known and potential impacts of the Highland Uranium Mill are considered. Topics covered include: physical characteristics of the facility, storage and disposal of solid and liquid wastes, environment in the area, environmental approvals and consultation, environmental impact of the mill, environmental effects that cannot be avoided, alternative courses of action, and the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity. (M.C.G.)

51575 (DOCKET-50201-82) WEST VALLEY REPROCESSING PLANT. Technical Specifications, Proposed Change. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 13 Aug 1971. 7p. Dep. NTIS.

A change is requested in Technical Specifications for Operating License CSF-1 to permit processing of plutonium nitrate–uranyl nitrate solutions. A safety evaluation is presented. (M.C.G.)

51576 (DOCKET-50201-85) WEST VALLEY REPROCESSING PLANT. Technical Specifications, Change No. 14 Authorized. (Division of Reactor Licensing (AEC), Washington, D. C.). 30 Aug 1971. 15p. Dep. NTIS.

Modifications are authorized for Technical Specifications 3.1 (Nuclear Fuel), 4.10 (Plutonium Solution Storage), and 6.1 (Boron Raschig Rings) of Provisions Operating License CFS-1. (M.C.G.)

51577 (DOCKET-50268-14) MIDWEST FUEL RECOVERY PLANT. Technical Specifications, Amendment 16, Request for Authorization to Receive Empty, Slightly Contaminated Casks. (General Electric Co., San Jose, Calif. Nuclear Fuel Dept.). 11 Aug 1971. 4p. Dep. NTIS.

Authorization is requested for receipt of empty but slightly contaminated IF 200 shipping casks, removal and storage in the fuel storage basin of the fuel support baskets presently in these casks, and insertion of new fuel support baskets designed for fuel from the San Onofre and Haddam Neck reactors. The principal requirement for radiation safety and protection during these operations for which authorization is requested is the detection of that portion of the residual contamination on the cask baskets and interior of the cask that may be released to the MFRP facility. (M.C.G.)

51578 (IFA-RC-6) LITERATURE SURVEY ON THE SEPARATION OF ISOTOPES BY ION-EXCHANGE. Sabau, Carmen; Calusaru, A. (Institutul de Fizica Atomica, Bucharest (Romania)). 1970. 40p. Dep. NTIS (U. S. Sales Only).

Two hundred and sixty three references on isotope separation by ion-exchange chromatography for the period 1922 to August 1970 are presented. References within sections are arranged by year of publication or declassification, then alphabetically according to author. The sections are: general articles on ion exchange, articles concerning individual elements, and ion-exchange in the general context of isotope separation. (M.C.G.)

51579 (IN-1196) PILOT-PLANT STUDY OF THE ELECTROLYTIC DISSOLUTION OF STAINLESS STEEL-CLAD FUEL. Brown, R. A. (Idaho Nuclear Corp., Idaho Falls). Jun 1971. Contract AT(10-1)-1230. 59p. Dep. NTIS.

The electrolytic dissolution of simulated and actual stainless steel-clad fuel was demonstrated in a pilot-plant unit. The pilot-plant dissolver, using continuous feed and discharge of solvent nitric acid, was operated successfully for more than 2000 hours. The anodic dissolution process is a function of the current passing through the dissolver; control of the current and the acid feed rate is sufficient for control of product uranium concentration. EBR-II fuel elements, consisting of 91 stainless steel-clad uranium pins, were dissolved at predicted rates with a very small loss of uranium in the undissolved solids. No hazards were indicated from dissolution of the sodium used as a bonding agent in these fuel pins. The observed dissolution rate of fuel was used to predict the general operating behavior of the plant-scale dissolver. (auth)

51580 (INR-1248) EXTRACTION OF URANYL NITRATE AND NITRIC ACID IN THE SYSTEM $UO_2(NO_3)_2$–HNO_3–$Mg(NO_3)_2$–H_2O–TBP. Gawlowska, Waclawa (Institute of Nuclear Research, Warsaw (Poland)). 1970. 59p. (In Polish). Dep. NTIS (U. S. Sales Only).

Extraction of uranyl nitrate and nitric acid in the system $UO_2(NO_3)_2-HNO_3-Mg(NO_3)_2-H_2O-$TBP was examined in the concentration range: 2 to 200 mg U/ml in 0 to 4 M HNO_3 and 10, 20, 30% vol TBP in mepasine. The term of stoichiometric ratio of the phases was introduced for calculations of the results. (auth)

51581 (JINR-D12-5845) CHEMICAL SEPARATION OF KURCHATOVIUM. Zvara, I.; Belov, V. Z.; Chelnokov, L. P.; Domanov, V. P.; Hussonnois, M.; Korotkin, Yu. S.; Shchegolev, V. A.; Shalaevskii, M. R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

Kurchatovium-259 was isolated from the products of the bombardment of ^{242}Pu with ^{22}Ne ions by frontal thermochromatography of chlorides on a glass column. The kurchatovium chloride molecules were found to be adsorbed on the column walls within the band of adsorbed hafnium tetrachloride molecules /isotopes $^{170,171}Hf$/, which served as a monitor. Under the given experimental conditions this band peaked at ≈250°. Eighteen kurchatovium atoms were detected by the fragments from spontaneous fission of their nuclei. It is shown that in all chemical experiments with kurchatovium performed at Dubna since 1966, the isotope ^{259}Ku was registered. (auth)

XUM

51582 (JINR–P12-5855) SORPTION OF ASTATINE CATION BY THE CATION EXCHANGE RESIN DOWEX 50 x 8 FROM THE AQUEOUS SOLUTIONS OF $HClO_4$. Chung, Do Kim; Dudova, I. V.; Khalkin, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Jul 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

Astatine, oxidized by bichromate, was reversibly sorbed from the aqueous solutions of $HClO_4$ by the cation exchange resin Dowex 50 × 8. The dependence $\lg K_d - \lg [HClO_4]$ in $0.3\ M \leq [HClO_4] \leq 1.5\ M$ is linear, the slope of the line is close to –1, which proves the assistance of singly charged ion in the ion exchange process. Astatine cation $At(X)^+$ forms complexes with a chloride ion ($\beta_1 = 1.6.10^3\ M^{-1}$ and $\beta_2 = 2.5.10^5\ M^{-2}$) in 0.5 M $HClO_4$. The data obtained prove that one and the same astatine ion is produced in HNO_3 and $HClO_4$ when oxidized by bichromate. $At(X)^+$ forms weak complexes ($\mu = 1$, 20°C) with nitrale-($\beta_1 = 1.35\ M^{-1}$), sulfate-($\beta_1 = 1.7\ M^{-1}$ and $\beta_2 = 3.2\ M^{-2}$) and bichromate ions ($\beta_1 = 22\ M^{-1}$). Enthalpy of the astatine cation sorption by the cation exchange resin is $\Delta H = -3300$ cal/mole. This fact as well as the others leads to the assumption that the sorption process in the given case is not an ordinary ion exchange process. (auth)

51583 (JUL–741-RW) DEVELOPMENT OF A METHOD FOR RECOVERY OF URANIUM FROM UNIRRADIATED COATED FUEL PARTICLES. Gerold, Hanns Dieter (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Mar 1971. 102p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

Development of a combined grind-burn-leach head-end procedure is described. The head-end procedure was developed sufficiently to allow the design of a prototype installation. For grinding of the particles, a roller proved most efficient, and a special type was developed. For the burning of pyrolytic carbon, a flow bed procedure was developed with a separate filter chamber. For removal of heavy metal components, a leaching installation was constructed, which consisted of a special recirculating evaporator and a hydrocyclon. Roller, flow bed, and leaching installation could be assembled into a closed system. In combination with the grinding procedure, a method was developed that permits a higher than 95% recovery of $(U,Th)O_2$ and ThO_2. As a consequence, reprocessing costs could be reduced markedly. (H.B.G.)

51584 (MLM–1792) MOUND LABORATORY CHEMISTRY AND PHYSICS PROGRESS REPORT: OCTOBER–DECEMBER 1970. (Mound Lab., Miamisburg, Ohio). 30 Jun 1971. Contract AT(33-1)-Gen-53. 36p. Dep. NTIS.

Research progress is reported on: ^{229}Th recovery, airport cake residues, ^{210}Po production, rate of change of Pu species concentration in dilute acid solutions, containment of volatile compounds for high-temperature x-ray diffraction, determination of Pu in soil, preparation of tritiated hydrogen gas standards, structural characterization of crystalline dipentaerythritol hexanitrate, x-ray fluorescence of thorium oxide-uranium oxide mixtures, spontaneous fission half-life of ^{238}Pu, differential scanning calorimeter analysis, and determination of plastic cure in molded parts. (M.C.G.)

51585 (ORNL-TM–3139) ENGINEERING DEVELOPMENT STUDIES FOR MOLTEN-SALT BREEDER REACTOR PROCESSING NO. 4. McNeese, L. E. (Oak Ridge National Lab., Tenn.). Aug 1971. Contract W-7405-eng-26. 129p. Dep. NTIS.

Research progress is reported on: semicontinuous reductive extraction experiments in a mild-steel facility, measurement of axial dispersion coefficients in packed columns, simplified method for estimating the effect of axial dispersion on countercurrent column performance, effect of axial dispersion in packed column contactors used for MSBR processing, axial dispersion in an open bubble column, electrolytic cell development, calibration of an orifice-head pot flowmeter with molten salt and bismuth, a bismuth-salt interface detector, and stripping of ThF_4 from molten salt by reductive extraction. (M.C.G.)

51586 (RT/PROT–(71)8) METHODS OF SEPARATION OF NOBLE FISSION GASES CONTAINED IN GASEOUS EFFLUENTS. Cardinale, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Aug 1970. 63p. (In Italian). Dep. NTIS (U. S. Sales Only).

Physical principles of the various methods of separation of noble fission gases contained in a current of gaseous effluents are reviewed. There is a brief description of the principle applications up to the present in the nuclear industry. Cost estimates for installations based on these principles and an enumeration of the advantages and disadvantages of each installation are included in tabular form. (tr-auth)

51587 (UJV–2567-Ch) PARTITION CHROMATOGRAPHY OF URANIUM AND FISSION PRODUCTS ON POROUS STYRENE-DIVINYLBENZENE COPOLYMER SWOLLEN IN TRIBUTYLPHOSPHATE SOLUTION. IV. EQUILIBRIUM DISTRIBUTION OF URANYL NITRATE BETWEEN SWOLLEN GELS AND THE AQUEOUS PHASE. COLUMN SEPARATION OF URANIUM AND FISSION PRODUCTS. Beranova, M.; Tejnecky, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Feb 1971. 19p. Dep. NTIS (U. S. Sales Only).

The equilibrium distribution of uranium between swollen gels of styrene-divinylbenzene copolymer and the aqueous phase was examined in relation to the nitric acid concentration in the aqueous phase. The values of uranium distribution ratios proved the original assumption, that tributyl phosphate in the swollen gel has a character of a solution in the corresponding diluent and the copolymer. From the equilibrium distribution of uranium and of single fission products, the optimal conditions for column separations were found. The column separations of uranium from $^{90}Sr-^{90}Y$, $^{95}Zr-^{95}Nb$, ^{106}Ru, and ^{144}Ce are described for the gel of the P-10 copolymer. (auth)

51588 CYCLIC UTILIZATION OF NUCLEAR FUELS. PLUTONIUM PRODUCTION AND ITS UTILIZATION. Yamazaki, Masao (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Nenryo Kyokai-shi; 49: No. 520, 592-602(Aug 1970). (In Japanese).

Fuel reprocessing to recover plutonium from spent fuel in reprocessing plants in the world is reviewed. The Purex Process has been used in almost all the plants. Block diagrams of this process and solvent extraction with mixer-settler are explained. Utilization of the recovered plutonium is indispensable with respect to the fuel cycle. The plutonium is used as fuels for many types of reactors, and future growth of peaceful use of nuclear energy depends on the utilization of plutonium for nuclear fuel. (Japan)

51589 SEPARATION OF La^{3+} FROM Cu^{2+}, Zn^{2+}, Ni^{2+}, Co^{2+}, AND Cd^{2+} (M^{2+}) BY SUITABLE COMPLEXING IN AN ALKALINE MEDIUM. Teodorovich, I. L.; Gutnikova, R. I. (Inst. of Chemistry, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 9, 35-6(1970). (In Russian).

The separation of the rare earth elements, particularly La^{3+} from the common divalent metal ions (M^{2+}) remains a difficult problem. The following reagents were tested for their suitability in effecting such a separation: KOH, KOH + glycine, and ethylenediamine. In these tests $La(OH)_3$ was precipitated at 70°C (from a $La^{3+} - M^{2+}$ pair) by one of these three reagents, dissolved in HCl, and coprecipitated with $La(OH)_3$. The accompanying Cu, Zn, Ni, Cd, or Co was determined by polarography, and it was concluded that the reagents KOH + glycine or ethylenediamine was satisfactory for such a separation. (K.S.W.)

51590 MANAGEMENT OF NUCLEAR FUEL REPROCESSING WASTES. Goldman, Morton I. (Nuclear Utilities Services Corp., Washington, D. C.). pp VIII.1-7 of Nuclear Power and the Environment. Madison, Wis.; Univ. of Wisconsin (1970).

From Conference on nuclear power and the environment; Madison, Wis. (3 Apr 1970). See CONF-700415.

The problem of radioactive wastes from fuel reprocessing is considered by following a typical fuel element from the reactor through its reprocessing and outlining the steps taken to control the fission products. It was concluded that management of radioactive waste from fuel reprocessing does not appear to pose significant or difficult problems for solution. The control of the so-called high-level wastes is a manageable although expensive process requiring eternal care. The best solution at present appears to be the storage of these materials underground in geological formations that are stable and isolated from the human environment. (D.H.M.)

51591 EXTRACTION OF URANIUM(IV) BY DI-2-ETHYL-HEXYL-PHOSPHORIC ACID FROM PERCHLORIC ACID SOLUTIONS. Kiwan, A. M.; Amin, R. S. (National Research Centre, Cairo). J. Inorg. Nucl. Chem.; 33: No. 7, 2221-8(Jul 1971).

The partition of uranium(IV) between perchloric acid solutions and solutions of di-(2-ethyl-hexyl)-phosphoric acid (HDEHPA) in carbon tetrachloride was investigated at varying concentrations of perchloric acid, extractant and uranium. In moderately acidic solutions of perchloric acid, uranium(IV) is extracted as $U(DEHPA)_2(H(DEHPA)_2)_2$. In strong acidic solutions, the original ion-exchange extraction mechanism is replaced by a solvation mechanism with the formation of the extractable complex $U(ClO_4)_4(HDEHPA)_n\ \ 2HCLO_4$. The ir spectra of uranium(IV) complexes in CCl_4 are also recorded and discussed. (auth) (UK)

51592 SORPTION OF SOME ACTINIDE IONS ON AMMONIUM MOLYBDOPHOSPHATE CHROMATOGRAPHIC COLUMNS. Ganzerli-Valentini, M. T.; Maxia, V.; Meloni, S.; Martinelli, A.

(Univ., Pavia, Italy). Radiochem. Radioanal. Lett.; 7: No. 3, 163-74(1 Aug 1971).

The sorption of thorium, uranium, and neptunium from nitric, sulfuric, and hydrofluoric acid solutions on AMP (ammonia phosphomolybdate) was studied and compared with batch experiments. The conditions for sorption and elution are different for the different ions. The sequence of decreasing sorption strength is: Np(IV) > Th(IV) ≫ U(VI) ≫ Np(VI) > Np(V). (auth)

51593 EXTRACTION OF YTTRIUM THIOCYANATE BY TRIBUTYL PHOSPHATE. Golub, A. M.; Tanchik, V. M. (Kiev Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 14: No. 4, 492-4(1971). (In Russian).

The extraction of $Y(SCN)_3$ solutions with TBP at a pH of 2.6 was studied over the temperature range 20 to 70°C, and the distribution coefficient (K_D) was found to decrease correspondingly from 9.45 to 1.00. It was further established that at pH values of either 1 or 2.7 the composition of the extracting compound passing into the organic phase was a neutral complex, $Y(SCN)_3$. Over a range of concentrations of the SCN^- ion the ratio $(SCN^-)^3/K_D$ was found to be constant: about 3.0×10^{-2} at a pH of 1.0, and 1.8×10^{-2} at a pH of 2.7. (K.S.W.)

51594 CHEMICAL COATING REMOVAL FROM FISSILE MATERIAL BUNDLES IN AN AZEOTROPIC MIXTURE OF HYDROFLUORIC ACID AND WATER. Seys, A. (Katolieke Univ., Leuven, Belg.); Spaepen, G. J. Ingenieursblad; 40: No. 9, 292-7(1971). (In Dutch).

A chemical coating removal process using an azeotropic mixture of hydrofluoric acid and water is discussed. Materials such as Stainless Steel 304 and 316, Inconel, and vanadium were investigated by determining the weight loss and the volume of hydrogen liberated in exposure tests. Electrochemical polarization techniques can also be applied for evaluating the process. Investigation showed that the coating removal from fissile material bundles in azeotropic mixture of hydrofluoric acid and water is a fast process and can be performed either to dissolve completely the coating material, or to corrode partially the material and afterwards mechanically remove the fragile residues. Inconel is a suitable coating material that can be cathodically protected by connecting it with the dissolving coating materials. (auth)

51595 DEUTERIUM ENRICHMENT FROM NATURAL ABUNDANCE BY GAS CHROMATOGRAPHY. Bruner, F.; Canulli, C.; Di Corcia, A.; Libertu, A. (Univ., Rome). Nature (London) Phys. Sci.; 231: No. 25, 1715-7(21 Jun 1971).

The possibility of using high resolution gas chromatography as a means of achieving low-cost isotopic enrichment was investigated, using very long packed columns, and the results encouraged investigation of the possibility of using the technique for routine enrichments. Methane was employed in the studies, containing 0.06% CH_3D; although the considerable isotope effect shown by CH_4 and CH_3D makes separation of the components relatively easy, the low initial D content makes the enrichment difficult and provides a good test of the feasibility of the method. A copper tube, 120 m long and 0.4 cm. internal diameter, was employed, packed with "Graphon," and the operational technique is described in detail; typical working procedures, wastes and yields are shown in tabular form. The results indicated that it would not be practicable to use the method for large-scale preparation of isotopes owing to high cost. Studies were made, however, to evaluate the influence of column diameter on HETP, and it was found that a column of internal diameter 1.6 cm and length 180 m gives a satisfactory performance. If the method is improved by the introduction of cascade type plant it may possibly be competitive with other techniques. (UK)

51596 ION-EXCHANGE KINETICS IN VERMICULITE. Lutze, W.; Miekeley, N. (Hahn-Meitner-Institut, Berlin). J. Phys. Chem.; 75: No. 16, 2484-8(5 Aug 1971).

Ion-exchange rates were measured for the Sr–Ba ion exchange and its reversal in vermiculite. The mathematical treatment of the exchange process showed that the experimentally obtained curves could not be interpreted by the simple theory of Helfferich. Isotopic exchange experiments with biionic Sr–Ba vermiculites have revealed that the self-diffusion coefficients of Sr^{2+} and Ba^{2+} depend strongly on the ionic composition of the exchanger phase. Extension of the theoretical treatment by introduction of concentration dependent self-diffusion coefficients into the computation of Helfferich's interdiffusion coefficients yielded much better, in one direction even almost exact, agreement between theory and experiment. (auth)

51597 COMPLEXES OF URANYL IONS WITH THENOYLTRIFLUOROACETONE AND DERIVATIVE OF PHENYL-3-METHYLPYRAZOLONE-5. Burtnenko, L. M.; Kononenko, L. I. (Inst. of General and Inorganic Chemistry, Kiev). Ukr. Khim. Zh.; 36: No. 12, 1213-17(Dec 1970). (In Russian).

Spectrophotometric studies were made of the formation of complex compounds in the system uranyl nitrate–thenoyltrifluoroacetone–organic base (antipyrine, dimethylaminoantipyrine, or diantipyrinylmethane). Complexes with the ratio $[UO_2] : [TTA] : [OB] = 1 : 2 : 1$ were extracted with benzene. The addition of the organic bases led to a significant increase in the degree of extraction. (tr-auth)

51598 INORGANIC ION-EXCHANGE CHROMATOGRAPHY ON OXIDES AND HYDROUS OXIDES. Fuller, Martin J. (Tin Research Inst., Greenford, Eng.). Chromatogr. Rev.; 14: No. 1, 45-76(May 1971).

A review of inorganic ion exchange chromatography on oxides and hydrous oxides is presented including mechanisms of ion exchange; structures of hydrous oxides; effects of surface area and thermal treatment on ion exchange properties; acidities; physical and acid-base stabilities; ion exchange capacities; chemical pretreatment; ion exchange kinetics; ion selectivities; sorption of metal complexes and elution by complex formation; sorption of hydrolytic products of cations; electrolyte sorption; and inorganic separations by ion exchange (thin layer, paper, column chromatography). 202 references (D.H.M.)

51599 NEW METHOD OF SEPARATION OF CALCIUM AND STRONTIUM APPLIED TO THE PREPARATION OF A CALCIUM SALT OF VERY LOW STRONTIUM CONTENT. Patti, F.; Hernandez, J. A. (CEA, Fontenay-aux-Roses, France). Anal. Chim. Acta; 55: No. 2, 325-32(Jul 1971). (In French).

A new separation of calcium and strontium based on the different solubilities of their hydroxides was developed. By precipitation of calcium hydroxide in a dilute sodium hydroxide solution, small amounts of strontium (1 to 500 mg) can be separated from large amounts of calcium; the separation yields were determined as a function of the amounts of available strontium and the concentration of the sodium hydroxide solution. The degree of selectivity of the separation was also studied. The method is applied to the preparation of calcium salts with a very low content of stable (2.9 ppM in relation to calcium) or radioactive strontium, which can be used either for the preparation of standards for the determination of stable strontium by x-ray fluorescence or flame photometry, or to obtain a "blank" for radiochemical analysis. (auth)

51600 EXTRACTION OF URANIUM(IV) AND URANIUM(VI) IN SLIGHT CONCENTRATIONS WITH DI-(2-ETHYLHEXYL)-PHOSPHORIC ACID FROM AQUEOUS PERCHLORIC ACID SOLUTIONS. Schmid, E. R.; Pfannhauser, W. (Univ., Vienna). Mikrochim. Acta; No. 3. 434-46(1971). (In German).

The distribution of uranium(IV) and uranium(VI) in slight concentrations (≤1.1 g/l) between bis(2-ethylhexyl) orthophosphate (HDEHP) in xylene and chloroform and aqueous perchloric acid solutions was studied in relation to the perchloric acid concentration, the proton concentration, the perchlorate ion concentration, and the HDEHP concentration. The uranium is extracted predominantly from weakly acid solutions (≤1.3 N) by an ion-exchange mechanism, while from strongly acid solutions the extraction is due primarily to a solvate mechanism. The distribution ratio D is strongly dependent on the kind of diluent and for uranium(IV) decreases in the sequence nitrobenzene > kerosene > cyclohexane > xylene > chloroform. For uranium(VI) the order is kerosene > nitrobenzene > cyclohexane > xylene > chloroform. With the exception of nitrobenzene, the distribution ratio is inversely proportional to the dielectric constant. (auth)

51601 FRACTIONATION OF OXYGEN ISOTOPES BETWEEN NO AND H_2O. Jordan, Siegfried; Bonner, Francis T. (State Univ. of New York, Stony Brook). J. Chem. Phys.; 54: No. 11, 4963-4(1 Jun 1971).

The isotopic equilibrium constant for the process $N^{16}O(g) + H_2{}^{18}O(l) = N^{18}O(g) + H_2{}^{16}O(l)$ was measured. The fractionation factor was measured under conditions such that a gas phase consisting exclusively of NO and H_2O is brought to equilibrium with a highly dilute aqueous phase. A mean value of 1.025 ± 0.003 was obtained for the fractionation factor. (M.C.G.)

51602 PURIFICATION PROCESS OF ISOTOPE EXCHANGE AGENTS OR ADJUVANTS TO ISOTOPE EXCHANGE AGENTS USED IN HEAVY WATER PRODUCTION. Lambert, Irma; Ravoire, Jean; Rochard, Elisabeth (to Commissariat a l'Energie Atomique). French Patent 2,041,455. 18 Jan 1971. Filed 24 Apr 1969. (In French).

This method for purifying isotope exchange agents or adjuvants of isotope exchange agents used in heavy water production consists of reacting the products to be purified with an alkali metal amide. The isotope exchange agents may be ammonia or secondary amines. The adjuvants added to ammonia are primary, secondary or ternary amines. (France)

51603 ISOTOPE EXCHANGE PROCESS BETWEEN THE AMMONIA OR AN AMINE AND THE HYDROGEN. Dirian, Gregoire; Lambert, Irma; Roth, Etienne (to Commissariat a l'Energie Atomique). French Patent 2,041,394. 18 Jan 1971. Filed 23 Apr 1969. (In French).

The isotope exchange process between hydrogen and liquid ammonia or liquid amine consists of reacting gaseous hydrogen with the ammonia or amine containing an alkali metal amide catalyst. A small amount of a surface active reagent was added to the solution. (France)

51604 DATA CORRELATION BETWEEN THE REDUCTION OF THE FREE ACID CONTENT AND THE URANIUM (U_3O_8) LEACHED FROM A CARNOTITE TYPE ORE IN RELATION TO LEACHING TIME. Munoz Ribadeneira, F. J. (Puerto Rico Nuclear Center, Rio Piedras); Munoz Candelario, R. Politecnica (Quito); 1: No. 2, 15-39(1968). (In Spanish).

Operational procedures employed when studying the leaching of uranium from a carnotite type ore by using ordinary batch type leaching operations, ultrasonic energy in the same geómetrical configuration, and sulfuric acid in different concentrations. The free acid content is determined by a method developed at this laboratory and the content of uranium by the method developed by Nietze and De Sessa. The ultrasonic treatment yielded more extraction of uranium than the normal lixiviation treatment. When the reduction of free acid content was plotted as a function of time, a "Three Region Empirical Model" was found. A semi-logarithmic relationship was found between the uranium leached from the ore and the free acid content. (M.C.G.)

51605 INDUSTRIAL DEVELOPMENT WORK CARRIED OUT AT THE La HAGUE UP 2 PLANT FROM 1967 TO 1970. Delange, M. (CEA, Cherbourg, France); Chambon, M.; Patigny, M.; Texier, P. Energ. Nucl. (Paris); 13: No. 2, 94-105(Mar-Apr 1971). (In French).

Since industrial starting up on the 1st of January 1967, the UP 2 plant of the La Hague Center has successfully carried out some experiments and development studies. The most interesting results concern: the behavior and performance of tridodecylamine, the stability of phosphomolybdenum complexes, the ability to carry out systematically the chemical decanning of MGR fuels while releasing magnesium into liquid effluents, the technical and economical advantage of U(IV) preparation processing by catalytic reduction with hydrogen under pressure, and the advantage of automatic analysis methods. Parallel tests conducted at the La Hague Center increased the UP 2 throughput from its 2 t/day nominal value to 4 t/day; multipurpose reprocessing on a European scale is envisaged in 1975/1976 with this plant. (auth) (France)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 51590 and 51919.

51606 (A/CONF.49/P-113) SEDIMENT STUDY AT KARACHI BY MEANS OF RADIOACTIVE TRACERS. Qureshi, M. H.; Ghauri, G. A.; Hussain, S. D.; Khan, N. A.; (and others) (Atomic Energy Centre, Lahore (Pakistan)). Jun 1971. 9p. (CONF-710901-368). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Studies were undertaken to determine the movement of sand around the Karachi Harbor using radioactive tracer techniques. One kg of scandium glass sand was irradiated in the reactor at PINSTECH to yield an activity of about 50 curies of ^{46}Sc. The radioactive glass tracer was injected at a point 3 miles from the entrance to the harbor and 2½ miles from Clifton foreshore. The tracer was then surveyed for its movement using water tight scintillation detectors towed by a boat in pre-monsoon and post-monsoon seasons. It is inferred that there is a slight movement during the pre-monsoon period preferentially in an easterly direction. During the monsoon period the movement is extensive and is towards northeast. (auth)

51607 (A/CONF.49/P-250) STUDIES ON THE PROTECTION OF OCEAN AND ATMOSPHERE FROM CONTAMINATION BY RADIOACTIVE WASTE DISPOSAL. Kadoya, S.; Sugimoto, S.; Hayashi, T. (Ebara Mfg. Co., Ltd., Tokyo, Japan); Murata, T.; (and others) (Hitachi, Ltd., Tokyo (Japan)). May 1971. 26p. (CONF-710901-193). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Research work on solidification of radioactive wastes in connection with deep sea dumping disposal and on designing off-gas treatment devices of nuclear power stations is reported. A review of the laboratory tests on leaching characteristics both of the cement-solidified and the bituminized products of simulated radioactive wastes is presented. Particularly, the leaching data of products of both types of solidification tested by the pressure and temperature equivalent to those of the sea depth of 4000 meters are provided. The effects of solidification are discussed with various solidification conditions such as by types of solidifying materials, radioactive wastes, mixing ratios, pressures, temperatures, etc. Three types of devices are covered on which a research is being carried out with an intention to improve their effectiveness and reliability. These are a rare gas holdup device, a catalytic recombiner of hydrogen and oxygen, and an activated charcoal filter. The basic data were obtained for these studies by employing a pilot-scale mock-up, use of a palladium-on-aluminum catalyst, and the removal of elemental iodine and organic iodides respectively, are included in discussion. (auth)

51608 (A/CONF.49/P-340) APPLICATIONS OF ISOTOPES AND NUCLEAR RADIATIONS IN ROMANIA. Ursu, Ioan (State Committee for Nuclear Energy, Bucharest, Rumania). May 1971. 28p. (CONF-710901-205). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A brief survey of the activities coordinated by the State Committee for Nuclear Energy concerning the applications of isotopes and nuclear radiations in the various fields of science and economy, economical and social life, according to the provisions of the nuclear program in Romania is presented. Some aspects considered are industrial applications, (prospection and exploitation of natural resources), introduction of some technologies based on nuclear techniques in metallurgical, building and building materials industries, development of applications in hydrology, hydrotechnics, and water supply problems. The situation and prospects of applications of nuclear techniques in agriculture and connected activities are discussed, with examples regarding various aspects e.g., soil fertilizing, plant growth stimulation, study of the environment—soil influence upon plants, of the influence of various kinds of fertilizers and some microelements on plant metabolism, photosynthesis and transport studies, investigations on seed germination stimulation and others. There are also described applications in agricultural entomology, concentrated on pest control in vine and fruit tree cultures. In connection with the field of isotope and nuclear radiation applications in medicine and biology, particular attention is given to research in diagnosis determination and therapeutics, especially for nuclear medicine techniques providing lower exposures to patients. There are also shown some radiobiological studies on cell functions and radiomicrobiological research. Some of the particular applications of isotopes and nuclear radiations are indicated, in connection with the necessities of the economic and social development of Romania. (auth)

51609 (A/CONF.49/P-434) USE OF RADIOACTIVE AND STABLE ISOTOPES IN AGROCHEMICAL INVESTIGATIONS. Sokolov, A. V.; Andreyeva, E. A.; Ginzburg, K. E.; Melnikova, M. K.; (and others) (Lenin All-Union Academy of Agricultural Sciences, USSR). Jun 1971. 26p. (CONF-710901-380). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Research in the USSR on the use of radioactive and stable isotopes for studying the interactions between soils, waters, and chemical fertilizers and the effects of these interactions on plant growth is discussed. (L.C.L.)

51610 (A/CONF.49/P-436) STATE AND PERSPECTIVES OF DEVELOPMENT OF NEUTRON PULSE TECHNIQUE OF WELL INVESTIGATION. Bespalov, D. F.; Erosolimskii, B. G.; Ivankin, W. P.; Kantor, S. A.; (and others) (State Atomic Energy Committee, USSR). Jul 1971. 22p. (CONF-710901-455). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The principles of the neutron pulse technique for well logging are described, and the development of instrumentation and the use of the technique in the USSR are considered. (D.H.M.)

51611 (A/CONF.49/P-509) SELECTED ENVIRONMENTAL STUDIES USING RADIOACTIVE ISOTOPES. Smith, D. B. (Atomic Energy Research Establishment, Harwell (England)); Richards, H. J. (Water Resources Board, Reading (England)). May 1971. 13p. (CONF-710901-227). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The measurement of naturally occurring tritium in the hydrological environment is discussed in relation to problems of ground water movement. An account is given of recent measurements of vertical flow-rate through the unsaturated zone of soft porous limestone (chalk) and a relatively impervious clay. The results from studies in the chalk showed that vertical movement is predominantly by intergranular seepage with a smaller component of movement through crack systems. Downward movement of water in the clay is by slower inter-granular seepage. These studies suggest revision of existing theories of water infiltration. The application of natural tritium measurements to induced recharge to ground water from nearby rivers is illustrated with examples from sandstone and chalk aquifiers in several areas. Additional information was obtained by the use of tritium added to a stream flowing past a series of abstracting boreholes. Tracer investigations of sediment movement over the seabed or in estuaries are discussed with particular reference to the problem of obtaining a quantitative tracer for silt movement studies. An examination of the alternative methods of obtaining a quantitative tracer by irradiation of the natural silt, by surface labelling of the silt or by the use of bulk-labelled ground glass resulted in the conclusion that radioactive ground glass provides the preferred tracer for quantitative field studies of silt transport. (auth)

51612 (A/CONF.49/P-539) APPLICATIONS OF RADIOISOTOPES AND RADIATION SOURCES IN INDUSTRY, RADIATION PROCESSING, AND HYDROLOGY: CURRENT STATUS IN INDIA. Iya, V. K.; Eapen, A. C.; Krishnamurthy, K. (Bhabha Atomic Research Centre, Bombay (India)). May 1971. 20p. (CONF-710901-235). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Cobalt-60 and ^{192}Ir sources are extensively used in the country for industrial radiography both during construction of new installations and for regular quality control in industry. Radiotracer techniques have also found wide application in the chemical and metallurgical industries for determining process parameters and for providing other valuable information. Many industrial leak detection problems have been resolved by radioisotope techniques. The application of nucleonic gages for the measurement of the thickness of metal sheets, foils and coatings, for level measurement in hoppers and closed vessels, and for the density measurement of slurries and powders is rapidly increasing and these are briefly described. The Indian radiation technology pro-

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gram envisages the production of ^{60}Co in magacurie quantities and its beneficial utilization in industrial irradiators. The present status of work in the field of radiation processing of fiber-polymer and concrete–polymer composites and the sterilization of medical products is described. In the field of hydrology, radiotracer techniques that have been widely employed for studying the movement of sediment in the major ports and harbors of the country are described. Such radioisotope techniques have also provided valuable information in the location and estimation of seepages in dams and canals and for borehole logging. Studies concerned with the use of natural and artificial tritium to estimate surface recharges to ground water are also mentioned. (auth)

51613 (A/CONF.49/P–634) APPLICATIONS OF STABLE AND RADIOACTIVE ISOTOPES IN HYDROLOGY AND SEDIMENTOLOGY. Roth, E.; Merlivat, L.; Courtois, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Cornuet, R.; (and others) (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr 1971. 16p. (In French). (CONF-710901–302). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Some results of a study by the CEA on the use of tracers in sedimentology are as follows: radioactive marking of muds (particularly difficult where it is desired not to affect their dynamic representativity); quantitative determination procedures, where the results are presented in a manner which enables the transport parameters to be quantified; tests designed to permit comparison with current semiempirical transport formulas; and fundamental studies concerned with the concept of the ideal tracer and the expression for correct mixing. The CEA has in recent years developed the applications of isotopes in surface and subterranean hydrology. Surface hydrology research has concerned: the use of radioactive tracers to measure rate of flow of watercourses; investigation of dam and canal leakages using radioactive, saline, and fluorescent tracers, in association with isotopic environmental analysis involving stable isotopes and tritium; lake balance investigations where the optimum method employs stable water isotopes; and dispersion of residual waters in seas and lakes using radioactive tracers. With regard to subterranean hydrology, and in addition to the use of artifical tracers, methods have been developed which involve environmental isotopes, i.e., thermonuclear tritium and ^{14}C for water dating. (auth)

51614 (A/CONF.49/P–769) STATUS OF AND REASONS FOR USING ISOTOPE TECHNIQUES IN HYDROLOGY. Bochin, N.; Dumitrescu, S. (United Nations Educational, Scientific, and Cultural Organization); Bradley, E.; Ferronsky, V. I.; (and others) (International Atomic Energy Agency, Vienna (Austria)). Jul 1971. 16p. (CONF-710901–451). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Although isotope hydrology is, by comparison with most other methods, a relatively recent technique, a number of important results have been achieved in several types of hydrological problems using both environmental and artificial isotopic methods. Environmental isotopes, essentially ^{18}O and deuterium, and tritium and ^{14}C, help hydrologists learn basic facts about a hydrological system, such as its origin, mixing processes, age or residence time, and rates of water movement. Hydrogeological hypotheses can be confirmed or discarded on the basis of isotopic data. Artificial radioisotope techniques also help the hydrologist in problems such as river discharge measurement, sediment transport, direction and velocity of groundwater movement, moisture measurement and leakage from reservoirs and canals. Other hydrologic applications depend largely on nucleonic instrumentation. For example, nuclear logging methods, using both natural radioactivity and several combinations of neutron and artificial gamma sources, are successfully applied in the exploration of underground waters. (auth)

51615 (A/CONF.49/P–790) HYDROLOGICAL ISOTOPIC TECHNIQUES FOR THE STUDY OF WATER RESOURCES IN MEXICO. Galvez, L.; Navarrete, M.; Andreu, B. (Universidad Nacional Autonoma de Mexico, Mexico City. Comision Nacional de Energia Nuclear, Mexico City). Jun 1971. 4p. (CONF-710901–331). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Mexico is a country with large arid and semiarid areas. Therefore, the evaluation of underground water resources is very important. Programs proposed or presently used for applying isotopic techniques for determining ground water and soil characteristics are described briefly. (L.C.L.)

51616 (KFK–1212) FINAL DISPOSITION OF RADIOACTIVE WASTE. Annual Report, 1969. Borchert, H.; Duerr, K.; Klarr, K.; (and others) (Gesellschaft fuer Strahlenforschung m.b.H., Munich (West Germany). Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). Nov 1970. 42p. (In German). Dep. NTIS (U. S. Sales Only).

Methods for final disposition of radioactive wastes in the Asse salt mine are presented. The site, installation, operation, and modification of the main entrance are discussed. Procedures are described for the disposition of low-, medium-, and high-activity wastes. Experimental studies include mining problems, in situ measurements, safety studies, hydrogeological examinations, and environmental monitoring. Plans for a prototype cavern depository are outlined. (H.B.G.)

51617 (USGS–474-114) SOUTHWEST–NORTHEAST CROSS SECTION, TATUM DOME, LAMAR COUNTY, MISSISSIPPI. Dribble-29. Eargle, D. Hoye (comp.) (Geological Survey, Denver, Colo.). 1963. Contract AT(29-2)-474. 3p. Dep. NTIS.

A map is presented which shows the location, stratigraphy, sedimentary rock structure, aquifers, and salt stock boundaries of the SW-NE cross section across Tatum Dome, Lamar County, Miss., the site of Dribble Event in the Vela Uniform Program. The map is based on data from drill holes, analyses of well logs, core drillings, and seismic and geologic surveys. (L.C.L.)

51618 (USGS–474-123) RADIOCHEMICAL ANALYSES OF WATER SAMPLES COLLECTED ON AMCHITKA ISLAND, ALASKA. Beetem, W. A.; Washington, C. L.; Janzer, V. J.; Schroder, L. J. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 40p. Dep. NTIS.

The tritium, gross alpha, and gross beta data for water samples from the Amchitka Island study area are presented. These data were obtained from samples analyzed by the U. S. Geological Survey between Oct. 1965 and Nov. 1970. Analyses of water samples are tabulated by increasing latitude and decreasing longitude of sampling points. The study area from which samples are reported lies within lat 51°00′ and 52°00′ N., and long 179°30′ and 178°30′ E. (auth)

51619 RADIOHALOS: SOME UNIQUE LEAD ISOTOPE RATIOS AND UNKNOWN ALPHA RADIOACTIVITY. Gentry, Robert V. (Oak Ridge National Lab., Tenn.). Science; 173: No. 3998, 727-31(20 Aug 1971).

Previously unreported lead isotope ratios, that is, values for the ^{206}Pb/^{207}Pb ratio ranging from about 20 to 60, primarily radiogenic in origin but unsupported by uranium decay, were determined in the inclusions of certain polonium halos by means of ion-microprobe techniques. Evidence for radiogenic ^{208}Pb unsupported by thorium decay may also be inferred from the existence of a composite polonium halo type with rings from the radioactive precursors of ^{208}Pb. Several new dwarf halo sizes seem to indicate the existence of unknown, very low-energy alpha-emitters. Furthermore, the three-ring "X halo" also provides evidence for an unknown series of genetically related alpha-emitters with energies in the range from 3 to 7 MeV. (auth)

51620 DETERMINATION OF LOW ACTIVITIES OF U-Ra-SERIES ELEMENTS USING A LIQUID SCINTILLATION SPECTROMETER. Prochazka, Hubert; Jilek, Rudolf (Inst. of Veterinary Medical Research, Brno). Jad. Energ.; 17: 117-20(1971). (In Czech).

Liquid-scintillation spectrometery was used for low activity determination of naturally-occurring uranium and radium with its short-lived daughters, lead-210, bismuth-210, and polonium-210 in water samples and in biological material. The samples were prepared either by evaporation of the water under examination or by ashing of biological material. The determinations were made by external or internal standards methods. The example of qualitative and quantitative calculation of examined elements is presented together with basic principles of the calculation. The method is suitable for examination of radioactively polluted water samples as well as for biological samples of ashed tissues. (auth)

51621 RADON CONCENTRATION MEASUREMENTS IN CAVES OF BUDAPEST. Viragh, Elemer; Urban, Aladar (Technical Univ., Budapest. Budapest Hygiene and Epidemiology Inst.). Period. Polytech. Elec. Eng.; 15: No. 1, 3-19(1971).

Tests were made to determine the concentrations of ^{222}Rn in the air in a cave system of the Gellért-Hill, Budapest. The determination was based on the Tsivoglov-method, which measures the α activity of the short-lived ^{222}Rn daughters bound to aerosol particles of air, and several types of aerosol samplers were investigated, including a sampler operating by electrostatic condensation. Test values involved efficiency of ventilation and concentrations at different spots in the caves. Maximum concentrations were found to be 1.1×10^{-11} Ci/l. This value as compared to 10^{-13} Ci/l concentration in air indicated that pulmonary doses of regular workers in the cave were likely to reach or exceed the maximum permissible dose. (B.L.M.)

51622 WELL LOGGING COMPENSATION METHOD AND APPARATUS. (to Pan Geo Atlas Corp.). British Patent 1,232,092. 19 May 1971. Priority date 10 Jul 1967, United States.

Well logging apparatus including compensation means to substantially eliminate the effects of mud, mud cake on the wall of the borehole, and wall rugosity is described. The density logging system comprises first and second logarithmic amplifier means, means for impressing on the amplifier means first and second input signals corresponding to the counting rates of a pair of detectors spaced at different distances from a γ-ray source, means for deriving from the amplifier first and second output signals that are uncorrected linear functions of apparent formation density, means for developing a correction from the output signals corresponding to mud cake thickness, and means for adding the correction signal to one of the output signals to provide a true formation output density signal. (B.L.M.)

51623 THIRD SYMPOSIUM ON SALT. VOLUME ONE. Symposium Held in Cleveland, April 22–24, 1969. Rau, Jon L.; Dellwig, Louis F. (eds.). Cleveland; Northern Ohio Geological Society, Inc. (1970). 481p. (CONF-690456–(Vol.1)).

Forty-six papers on the geology, geochemistry, mining, and underground-storage uses of salt deposits were presented at the conference and are included in this volume. A separate abstract was prepared for each of 2 papers. Forty-four were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 51624 and 51778.

51624 GAMMA-RAY LOGS AND THE ORIGIN OF SALT. Rickard, Lawrence V. (New York State Museum and Science Service, Albany). pp 34-9 of Third Symposium on Salt. Vol. 1. /Rau, Jon L. (ed.). Cleveland; Northern Ohio Geological Society, Inc. (1970).

From third international symposium on salt; Cleveland, Ohio (22 Apr 1969). See CONF-690456–(Vol.1).

Stratigraphic relationships in the Upper Silurian Salina Group in New York, Pennsylvania, Ohio and Ontario were determined through a study and correlation of 435 sample and gamma-ray logs. Although the Michigan and Appalachian basins are structurally distinct, nearly identical rock units can be recognized in each. Subsurface units in these basins have been correlated with formations defined from surface exposures. The Vernon Shale of New York correlates with the Bloomsburg and Wills Creek formations of Pennsylvania and divisions A, B, and C of the Michigan subsurface. The Syracuse Formation corresponds to the Tonoloway and divisions D thru F4. The Camillus and Bertie formations are equivalent to the uppermost Tonoloway and lower Keyser and division F5, F6 and G. In the Appalachian basin, salt beds occur in the Vernon and Syracuse formations. Vernon salts can be traced 300 miles from central Michigan through Ohio and Pennsylvania into central New York. Certain deflections on gamma-ray logs can be traced over 600 miles from western Michigan to central New York. Comparison of gamma-ray logs suggests that thick halite beds formed rapidly relative to the deposition of intervening rock layers, supporting the proposition that basin floor subsidence occurs before the deposition of salt beds. A hypothetical depositional model suggests that salts formed in both shallow and deep water at rates 100 times those of the intervening sediments. (auth)

51625 THIRD SYMPOSIUM ON SALT. VOLUME TWO. Symposium Held in Cleveland, April 22–24, 1969. Rau, Jon L.; Dellwig, Louis F. (eds.). Cleveland; Northern Ohio Geological Society, Inc. (1970). 492p. (CONF-690456–(Vol.2)).

Fifty-four papers on the production, mining, and uses of salt were presented at the conference and are included in this volume. A separate abstract was prepared for each of 3 papers. Fifty-one were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 51626, 51738, and 54244.

51626 MECHANICS OF HYDRAULIC FRACTURES IN SHALES. McClain, William C. (Oak Ridge National Lab., Tenn.). pp 410-20 of Third Symposium on Salt. Vol. 2. /Rau, Jon L. (ed.). Cleveland; Northern Ohio Geological Society, Inc. (1970).

From third international symposium on salt; Cleveland, Ohio (22 Apr 1969). See CONF-690456–(Vol.2).

The Oak Ridge National Laboratory is now using an adaptation of the oil-field technique of hydraulic fracturing for the disposal of some of its liquid radioactive wastes. In this adaptation, the aqueous wastes are mixed with Portland cement and other solids and then pumped into a hydraulically-induced horizontal fracture in shale rocks at about 1000-ft depth. Since 1966 about 515,000 gal of waste containing more than 215,000 curies of activity have been disposed of by this method. The rocks overlying the solidified grout sheets provide the primary isolation and containment barrier for the wastes, and their integrity must be preserved. The development of the hydraulic fracturing waste disposal method therefore required an examination of both the mechanics of the induced fractures and the influence which each injection has on the surrounding rocks. These investigations indicated that the orientation of fractures is apparently controlled by both the state of stress in the ground and the anisotropy, that is, the bedding planes, of the shales. However, each injection imposes a stress field on the rocks which results in an uplift of the surface over the grout sheets and at the same time contributes toward the creation of a stress condition where some future fracture may be vertical instead of horizontal. Although hydraulic fracturing has been an extremely successful waste-disposal method at Oak Ridge, it does not follow automatically that it can be used at any other location. The technique is predicated upon the formation of horizontal rather than vertical fractures, and each proposed site must be extensively tested in order to prove that the fractures are indeed horizontal, or at least conformable in a nearly horizontal formation. Unequivocal proof of fracture orientation will require several core holes from the surface and intersecting the grout sheets, but a number of techniques can be used to obtain presumptive evidence of fracture orientation, thereby reducing the number of core holes required. Some of these, including analysis of fluid pressures at breakdown, and during and after the injection, measurement of surface uplift, and the detection of micro-seismic signals generated by the propagating tip of the fracture, will be tested during an experimental site examination in western New York state during the coming summer. (auth)

51627 TRITIUM HYDROLOGY. Libby, W. F. (Univ. of California, Los Angeles). pp 49 of Transactions of the Isotopic Snow Gage Information Meeting. Boise, Idaho; Idaho Nuclear Energy Commission (1970).

From Isotopic snow gage information meeting; Sun Valley, Idaho (28 Oct 1970). See CONF-701053.

The development of uses of atmospheric tritium, produced by cosmic radiation or nuclear explosions, for studying atmospheric circulation and patterns of flow in the hydrosphere is briefly described. (L.C.L.)

51628 RADIOACTIVITY OF CERTAIN MINERAL WATERS IN THE RODNEI MOUNTAINS. Barabas, B.; Filep, V.; Cojocaru, Doina. Rev. Med. (Tirgu-Mures); 16: No. 2, 168-71(1970). (In Rumanian).

The radioactivity of the mineral waters in the Rodnei Mountains was determined using closed circuit ionization and scintillation counters. The former had higher results than the latter by approximately 25% in radon and 35% radium determinations. The difference is due to certain systematic errors of the ionization chamber method. Therefore, the results were evaluated according to the scintillation method. The radon content of the waters studied varied between 0.07 to 1.13 nCi/l, and the radium content between 0.016 to 19.5 pCi/l. (auth)

51629 ^{234}U/^{238}U AS A TOOL FOR DATING MARINE SEDIMENTS. Krishnamoorthy, T. M.; Sastry, V. N.; Sarma, T. P. (Bhabha Atomic Research Centre, Bombay). Curr. Sci. (India); 40: No. 11, 279-81(5 Jun 1971).

A method for dating marine sediments using the decrease of ^{234}U/^{238}U activity ratio in the calcium carbonate phase was developed. A selective leaching agent $NH_4Ac \cdot HAc$ buffer was used which attacks only the calcium carbonate phase and very little of the other phases. The rate of sedimentation for the core, M-230 (Lat. 23° 10′N, Long. 67° 50′ E) from Indian Ocean was found to be 1.16 mm/1,000 yrs by this method. The calculated ionium value for the particular water column depth and for the typical composition of the top layer of the sediment was 1.58 dpm/g and agrees very well with the actual value of 1.28 dpm/g observed, considering the uncertainties in the parameters used. (auth)

51630 FIELD MEASUREMENT OF SOIL-WATER CONTENT BY GAMMA-RAY TRANSMISSION COMPENSATED FOR TEMPERATURE FLUCTUATIONS. Reginato, Robert J.; Jackson, Ray D. (Water Conservation Lab., Phoenix, Ariz.). Soil Sci. Soc. Amer., Proc.; 35: No. 4, 529-33(Jul-Aug 1971).

Soil-water content under natural field conditions was measured with a gamma-ray transmission technique that compensated for temperature changes. A spectrum stabilizer was needed for the nuclear counting equipment, and a knowledge of the relationship between peak count-rate and the temperature of the gamma-ray detector probe was required. Equipment and procedures to make field measurements of water content in 1-cm-thick soil layers are described. When the detector probe temperature varied 23°C and gravimetric water content ranged from 0.021 to 0.186 gg^{-1} over a

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measurement period, the average deviation of measured versus calculated values of water content was 0.009 gg^{-1}. (auth)

51631 THERMOLUMINESCENCE OF BIOLOGICAL MATERIALS. Christodoulides, C.; Fremlin, J. H. (Univ. of Birmingham, Eng.). Nature (London); 232: No. 5308, 257-8(23 Jul 1971).

It has been suggested that the thermoluminescence of fossil bones and other biological materials might be employed for dating purposes, but difficulties arise due to tribothermoluminescence (TTL) and chemiluminescence (CL) associated with residual organic material. Attempts have been made to eliminate these two problems, and while they have not yet been eliminated entirely, they have been reduced sufficiently to allow an approximate dating of the older more heavily irradiated materials. Much of the CL is due to simple oxidation and can be avoided by heating the material in N_2 during readout, and most of that remaining can be eliminated by organic extraction. The TTL is reduced by rejection of the finer powder. Some results are described for fresh bone powder treated in various ways. It was found, however, that the combined effects of residual CL and TTL are equivalent to a radiation dose of the order or 10kR, which is still too great for accurate results to be obtained for the region of 10 to 100 thousand years, but useful measurements can be obtained for 100,000 to a few million years. Above ten million years saturation effects progressively reduce the attainable accuracy. Further research on the elimination of CL by the use of enzymes has met with limited success. Some other remaining problems are briefly discussed. (UK)

Meteorology

Refer also to abstracts 51627 and 54008.

51632 (A/CONF.49/P-318) METHOD FOR THE DETERMINATION OF LONG-RANGE TRANSPORT OF ATMOSPHERIC SULPHUR. Bergstroem, Stig O. W.; Devell, Lennart; Gyllander, Christina; Hesboel, Rolf; (and others) (Aktiebolaget Atomenergi, Studsvik (Sweden)). May 1971. 15p. (CONF-710901-273). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A method to study sulfur oxide transport and conversion mechanisms of SO_2 to SO_3 by the combined use of radioactive and nonradioactive tracers is described. A first full-scale test over a distance of three hundred kilometers is discussed against the background of results from pilot tests with the fullscale test equipment. The feasibility with regard to radiological protection aspects is demonstrated. (D.H.M)

51633 (FOA-4-4460) RADIOACTIVE TUNGSTEN IN THE ATMOSPHERE FOLLOWING PROJECT SCHOONER. Persson, Gunnar (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Apr 1971. 7p. Dep. NTIS (U. S. Sales Only).

The ^{181}W concentrations observed in ground-level air in Sweden are given and compared to observations at other locations. The integrated ^{181}W-concentration in Swedish ground-level air was of the order 10 fCi-days/kg. (auth) (Sweden)

51634 MEASUREMENT OF ATMOSPHERIC RADIOACTIVITY. Suschny, O. WMO-No. 231.TP124(1968). Technical Note No. 94. Geneva; World Meteorological Organization (1968). 122p. $10.50. UNIPUB, Inc., New York.

The book is divided into 8 chapters. Chapters on atmospheric radioactivity and its origin; transport and removal of atmospheric radioactivity; collection of air samples; collection of rain, snow, and dry precipitation; processing and measurement of samples; monitoring systems in different countries, and standardization and intercalibration of measurements are included. Techniques and equipment in use in different stations in some 30 countries were surveyed. 151 references are cited. (B.L.M.)

51635 TUNGSTEN ISOTOPES IN FRESH RADIOACTIVE FALLOUT IN DECEMBER 1968. Izrael, Yu. A.; Ter-Saakov, A. A.; Malakhov, S. G.; (and others). At. Energ. (USSR); 30: No. 4, 377-80(Apr 1971). (In Russian).

During the middle of December 1968, newly formed radioactive products were detected in air samples and the fallout collected in the European and Central Asian portions of the Soviet Union. At the same time it was announced in the press that on Dec. 8, 1968, a 35 kiloton underground nuclear device was exploded at the Nevada Test Site, at a depth of 106 m during the Schooner tests, releasing activity beyond the boundaries of the United States. The air samples collected after Dec. 15, 1968 in Moscow contained a product exhibiting a 59 keV γ line and a half-life of about 140 days which identified it as ^{181}W. The mean daily concentration of ^{181}W near Moscow reached 4.6×10^{-14} Ci/m^3. In Archangels and Novosibirsk only very slight amounts of the activity were noted; at Chita and Vladivostok, no activity was found. Estimation of the ^{181}W activity in the ~150-km wide cloud passing through the Soviet Union resulted in the conclusion that tungsten isotopes, including ^{185}W found in the fallout from the American test, was due to the direct activation of the structural materials of the device by the neutrons from the explosion. (TTT)

51636 WASTE HEAT AND FOG CONTROL. Conn, Robert (Univ. of Wisconsin, Madison); Papay, Lawrence T. Nucl. Technol.; 12: No. 3, 269-75(Nov 1971).

The use of reactor waste heat to prevent the formation of advection fogs, particularly those off the coast of southern California, was investigated. It was found that the formation of these fogs can be inhibited by heating the surface of a cold band of off-shore water which acts as a catalyst in the sequence of steps leading to fog formation. The surface water of the cold band (colder than the surrounding waters by 1 to 4°F) can be heated with reactor waste heat to raise its temperature to that of the surrounding waters. An estimate is given of the number of installed electrical megawatts required to produce the heat necessary to raise the temperature of the cold tongue a specified amount. The parameters of the cold tongue are based upon sea surface isotherms. The use of reactor waste heat to reduce the intensity (thereby improving visibility) in an existing advection fog is also examined. A mathematical model of advection fog, originally developed by Rodhe and used by McVehil, was employed. It was found that a strongly non-linear gain in visibility is achieved as the sea surface temperature (temperature at the fog base) is raised. A discussion is included of future studies required to investigate in more detail the feasibility of the ideas presented. (auth)

Mineralogy and Exploration

Refer also to abstracts 51552, 51561, 51696, and 52420.

51637 (A/CONF.49/P-13) URANIUM SOURCES, PRODUCTION AND DEMAND IN ISRAEL. Ketzinel, Z. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev). Apr 1971. 12p. (CONF-710901-66). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The only uranium sources in Israel are phosphate deposits. Proven phosphate reserves are 220 million tons, and the corresponding amount of uranium is about 25,000 tons. A small part of the uranium in the phosphates mined in Israel could be recovered economically. Processes developed for uranium recovery as a by-product of phosphoric acid production make it possible to produce 50 tons a year at the present rate of phosphoric production in the country at world's market prices. A nuclear power program under favorable consideration at present, would have Israel build its first reactor in 1978 and two more in 1982 and 1984. If uranium production starts in 1972, the cumulative production and demand would both reach about 600 tons in 1984, which means that from that year on, the demand will be greater than production. (auth)

51638 (A/CONF.49/P-154) URANIUM AND THORIUM IN CANADA: RESOURCES, PRODUCTION, AND POTENTIAL. Williams, R. M. (Department of Energy, Mines and Resources, Ottawa (Ontario). Mineral Resources Branch); Little, H. W. (Department of Energy, Mines and Resources, Ottawa (Ontario). Geological Survey); Gow, W. A. (Department of Energy, Mines and Resources, Ottawa (Ontario). Mines Branch); Berry, R. M. (Eldorado Nuclear Ltd., Port Hope (Ontario)). May 1971. 21p. (CONF-710901-172). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The history of Canada's uranium industry is marked by a period of rapid expansion in the 1950's and an equally dramatic decline in the 1960's. Although short-term markets are weak, the industry looks forward with optimism to new expansion in the mid-1970's, based on the demand for nuclear fuel. Uranium production has been entirely from the southern and western parts of the Canadian Shield. The greatest production, reserves, and short-term potential are from uraniferous quartz-pebble conglomerates in Early Proterozoic sedimentary basins. Vein and replacement deposits have provided much uranium, and minor production has come from pegmatitic deposits. However, rocks younger than Precambrian that are also geologically favorable for uranium are widespread, and are expected to yield significant deposits. Canadian conglomeratic uranium ores contain significant quantities of thorium, available as a byproduct of uranium. Thus, Canada is potentially a major world supplier of low-cost thorium. The various Canadian ore types have been processed with either the acid-sulphate or the carbonate-bicarbonate leaching system, and the methods used to recover uranium from the leach liquors produced have included ion exchange, solvent extraction, and direct precipitation. However, investigations have indicated numerous possibilities of modifying the proven techniques in the design of future Canadian plants to reduce costs, and to produce high-purity uranium as well as thorium and rare-earth byproducts. Canadian capabilities and techniques have been developed for refining and converting uranium concentrates to the various chemical and physical forms required by reactor fuel fabricators. Significant quantities of orange oxide (UO_3), ceramic oxide powder (UO_2), uranium hexafluoride (UF_6), uranium metal, and alloys of uranium metal have been produced. Only a fraction of Canada's known low-cost uranium reserves and its mining and refining capabilities are presently committed; its unexplored potential is great. Canada's future in uranium supply is excellent. (auth)

51639 (A/CONF.49/P-349) PRESENT STATE OF EXPLORATION AND RESERVES OF NUCLEAR RAW MATERIALS IN YUGOSLAVIA. Pantic, R.; Simic, V.; Jokanovic, V.; Antonovic, A. (Institute of Geological and Mining Exploration, Belgrade). May 1971. 13p. (CONF-710901-116). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Data from 1948 to 1970 on investigations of uranium deposits in Yugoslavia are presented. Of the deposits discovered, the most important are those of the infiltration metamorphogenic type in Permian sandstones near Zirovski and of the hydrothermal type in tertiary volcanites in the Zletovska area. About 40% of the promising areas in Yugoslavia remain to be prospected. The probability of finding new deposits is high. It is believed that there is a potential raw material reserve in Yugoslavia which would result in 30,000 to 40,000 tons of U_3O_8. (L.C.L.)

51640 (A/CONF.49/P-489) UNITED KINGDOM RESEARCH AND DEVELOPMENT WORK IN AID OF FUTURE URANIUM RESOURCES. Davis, Michael (United Kingdom Atomic Energy Authority, London (England)); Bowie, S. H. U.; Ostle, D. (Institute of Geological Sciences, London (England)); Loosemore, W. R.; (and others) (Atomic Energy Research Establishment, Harwell (England)). May 1971. 14p. (CONF-710901-217). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Research in the UK for developing uranium resources is described and includes the development of uranium prospecting methods and instruments, a geological reconnaissance program for uranium occurring in the UK, and a study of improved methods for uranium ore processing. Instrument developments include the design, leading to production, of a probe-type monitor capable of making in-situ determinations of radon in ground air. Efficacy of this technique in resolving uranium exploration problems is demonstrated. The successful integration of prospecting techniques in the discovery of uranium occurrences in selected areas of the UK is described and an assessment made of geochemical techniques applied. It has yet to be shown whether these occurrences have any economic significance, but the methods employed should be of value in many parts of the world where uranium occurrences are obscured by peat, drift or other overburden. Research and development into uranium ore processing has aimed at improving the extraction of present and marginally economic ores, the main topics of investigation being up-grading, particularly lump ore sorting, new methods of chemical leaching, bacterial leaching, and in-pulp purification processes: some of these also being relevant in the longer term to lower grade ore sources. Where possible, collaboration internationally has avoided wasteful duplication: collaboration with industrial companies ensures that the instruments and the processes are available to industry and relevant to their needs. (auth)

51641 (A/CONF.49/P-531) URANIUM AND THORIUM RESOURCES AND DEVELOPMENT OF TECHNOLOGY FOR THEIR EXTRACTION IN INDIA. PART 1. GEOLOGY AND OCCURRENCE OF URANIUM AND THORIUM. PART 2. DEVELOPMENT OF METHODS FOR RECOVERY OF URANIUM AND THORIUM. Dar, K. K.; Jayaram, K. M. V. (Department of Atomic Energy, New Delhi (India)); Bhatnagar, D. V. (Uranium Corp. of India Ltd., Jaduguda); Garg, R. K.; (and others) (Bhabha Atomic Research Centre, Bombay (India)). May 1971. 17p. (CONF-710901-233). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Thorium and uranium reserves in India are estimated to contain about 33,000 short tons of U_3O_8 and 378,000 short tons of ThO_2. Further possible additional resources are estimated to contain about 30,565 short tons of U_3O_8. The cost of recovery of the resources would be in the range $10 to $30 per pound of U_3O_8 depending on the nature, quality and location of the deposit. While the principal uranium deposits are in the Singhbhum Thrust Belt in South Bihar, other possible locations are described. Intensive exploration of the deposits is being conducted employing geochemical and emanometry techniques. To process the low-grade ores (0.06 to 0.07% U_3O_8) of Bihar, a mill with a production capacity of 1000 tons of uranium has been in operation since August 1967, using the conventional acid leach ion-exchange process. Further work being carried out on improvement of this process for obtaining better recovery of uranium is described. Results of batch heap-leaching studies conducted on Bihar and Rajasthan ores are presented. These indicate a recovery of about 70 to 80 per cent of U_3O_8 is possible. Results of investigations on the prospects of recovery of uranium as a by-product in the copper industry and in the manufacture of phosphoric acid by the wet acid process have been reported. Pilot plant studies have been conducted on the extraction of uranium and thorium from the crude thorium cake obtained by the caustic breakdown of monazite and subsequent partial leaching of the hydroxide cake. Processes for conversion of pure thorium nitrate to the oxide are also being studied. (auth)

51642 (A/CONF.49/P-560) PERSPECTIVE ON THE RESOURCES AND DEMAND OF URANIUM IN ARGENTINA. Stipanicic, Pedro N. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). May 1971. 19p. (In Spanish). (CONF-710901-491). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The development of the uranium industry in Argentina can be divided in three periods. The first one (1950 to 1957) includes the formation of a group of technicians, to establish the basis of this new industry in the fields of prospecting and exploring uraniferous deposits, ore processing, and uranium concentrate refining and related problems of analytical chemistry. In the second period (1958 to 1969), a better availability of skilled personnel and operating facilities and installations permitted the physical exploration of uraniferous deposits, and laboratory and pilot plant scale studies of ore processing. In the last five years of this period a regular production of yellow cake, in the amount of 30 tons of U per year, was recorded. The third stage began in 1970 and is based on the supply of uranium for the Argentine Electric Nuclear Program, beginning with the installation of the first power reactor (Atucha I, 319 MW(e)). To satisfy the future demand, the local prospects for this industry were analyzed, considering the rate requirements, reserves, production capacity, the costs of the concentrates (they must be less than $10/lb U) and the final refined product (UO_2). The analysis has a sufficiently defined basis for the decade 1970 to 1980 and the same is extrapolated to the year 1985, taking into account the estimates of energy demand of the country and the participation of other conventional sources of energy, e.g., hydraulic, oil, gas, and coal. (auth)

51643 (A/CONF.49/P-678) URANIUM RESOURCES, PRODUCTION, AND DEMAND. Boxer, L. W.; Haeussermann, W. (European Nuclear Energy Agency, Paris (France)); Cameron, J.; Roberts, J. T. (International Atomic Energy Agency, Vienna (Austria)). Jun 1971. 23p. (CONF-710901-319). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The post-Geneva 1964 expectation of a shortage of low-cost uranium for power reactors prompted ENEA to study the possible long-term pattern of supply and demand of nuclear fuel in western Europe. Since 1966, the studies on uranium have been carried out jointly with the IAEA, in order to gain access to information from uranium-bearing territories outside the OECD area. The knowledge about uranium reserves likely to be mined and milled for a cost of lower than 10$/lb U_3O_8 was developed from some 600,000 short tons in 1965 to 700,000 in 1967 and 840,000 in 1970. Recent discoveries, mainly in Australia, indicate that the actual figure might well lie somewhat over one million short tons of low-cost uranium. These developments have dissipated earlier fears of nuclear power growth being hindered by a shortage of low-cost uranium reserves. The overall cumulative uranium production in the western world until 1970 was of the order of 450,000 short tons of U_3O_8 and the actual production rate is 23,000 short tons U_3O_8 per year. The development of the uranium demand has not kept pace with production. The current annual demand is 15,000 short tons. However, uranium demand is estimated to rise steeply in the seventies and the cumulative demand from 1970 to 1985 could amount to about one million short tons of U_3O_8. New production capacity would therefore be required during the second half of this decade, and new uranium reserves would have to be developed continuously if the usual forward mining reserve in the uranium industry of 8 to 10 years is to be retained. It is still too early to

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predict the influence on the uranium market of the advent of breeder reactors. However, it seems to be accepted that part of the plutonium produced in thermal reactors will be recycled, thus decreasing uranium consumption correspondingly. (auth)

51644 (A/CONF.49/P-781) URANIUM DEPOSITS IN TURKEY. Ayan, Mehmet (Mineral Research and Exploration Inst., Ankara (Turkey)). Jun 1971. 10p. (CONF-710901-454). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Turkey initiated radiometric prospecting and exploration for uranium about 1957 and since that time a large portion of the country has been prospected and studied. This work has been accomplished largely by the Mineral Research and Exploration Institute of Turkey in Ankara with some technical assistance, in some cases from the Turkish Atomic Energy Commission. From the results obtained up to date, it seems possible to recover more than 2,500 metric tons of U_3O_8 from the known uranium reserves, at market prices. In the case of thorium, the results have been very satisfactory. The geological situation of some uranium occurrences is described and the results obtained in the regions are presented. Prospecting and investigation methods are presented in detail and some economic data on the explored area and reserves are given. The future prospects for the mining of uranium and thorium in Turkey are reviewed in light of the results obtained to date. Finally, according to the systematic program given, present radioactive mineral resources in Turkey are compared with needs in future years. (auth)

51645 BEHAVIOR OF THE RARE EARTHS AND URANIUM IN VESUVIANITE SKARNS. Nozhkin, A. D. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Geol. Geofiz.; No. 9, 60-5(Sep 1970). (In Russian).

It is shown that vesuvianite mineralization develops at weakened zones among garnet-pyroxene skarns. Vesuvianite is characteristically associated with hastingsite, apatite, and xenotine—minerals, which contain volatile constituents and water. Vesuvianite formation is accompanied by the active concentration of yttrium-predominant rare earths (up to 7.4%) and uranium (0.4%), isomorphically replacing calcium in the crystal structure of this mineral. Recrystallization of vesuvianite skarns, promoted by the superposition on them of subsequent quartzitic and feldsparhic mineralization, is accompanied by a "scrubbing" of the crystal structure of vesuvianite from rare earths and uranium. During this process the rare earths are carried away by metamorphizing solutions, and uranium undergoes only redistribution, its occurrence in a mineral being in the form of a thinly dispersed oxide. (tr-auth)

51646 SOME PATTERNS OF SULFUR ISOTOPE DISTRIBUTION IN URANIUM DEPOSITS. Austin, S. Ralph. Earth Sci. Bull.; 3: No. 2, 5-22(1970).

Distribution patterns are discernible in sulfur isotope composition in sandstone-type uranium deposits. In four ore rolls from three Wyoming districts, $\delta\,^{34}S$ increases sharply from barren interior to ore, at or near the natural contact or solution front, then gradually from ore to protore. Probable biological reduction of sulfur is an important part of the ore-forming process. Sulfur-32 enrichment for sulfides associated with woody or coaly material is confirmed. Lightest sulfur ($\delta\,^{34}S$ – 53.11 per mil) is in marcasite associated with petroleum along a fault in a uranium deposit in Texas. In samples from Wyoming and Colorado sulfur in sulfides from Serich zones is light, that associated with Mo is heavier. Relatively heavy sulfur ($\delta\,^{34}S = -5.0$ per mil) in sulfides from the Sunset pit, wastern ore trend, Gas Hills, Wyoming, suggests a broad areal pattern. (Abstr. N. Amer. Geol.)

51647 ISOTOPIC COMPOSITION OF SULPHUR IN CARBONATITE AT MOUNTAIN PASS, CALIFORNIA. Mitchell, R. H.; Krouse, H. R. (Univ. of Alberta, Edmonton). Nature (London) Phys. Sci.; 231: No. 25, 182(21 Jun 1971).

It was found that galena from carbonatite has an unusual isotopic composition compared with other carbonatite sulfides and sulfides from igneous rocks in general. S isotope data for galena and barite from Mountain Pass are shown tabulated and compared with data for other carbonatite bodies. The Mountain Pass samples show a higher ^{34}S enrichment than hitherto reported in carbonatites or sulfides closely associated with igneous rocks, and the only ore deposits known to show similar $\delta\,^{34}S$ values are those of sandstone-type U deposits and red-bed Cu deposits, where the isotopic composition has been ascribed to bacteriological fractionation processes, the latter, however, being inapplicable to the Mountain Pass galenas. It is suggested that the isotopic fractionation observed in the latter case is a consequence of unusual oxidation conditions occurring in the magma and the relatively low sulfide deposition temperature. (UK)

51648 IVORY COAST MICROTEKTITES: CORRECTED VALUES OF URANIUM CONTENT. Durrani, S. A.; Khan, H. A. (Univ. of Birmingham, Eng.). Nature (London) Phys. Sci.; 232: No. 34, 175(23 Aug 1971).

Corrections are made to the values given in Nature 232:320 (1971). The errors arose because the authors did not appreciate that the reference glass contained depleted U and not natural U, leading to ≈15 μm, rather than 7.6 μm, for the apparent range of an average fission fragment in glass and practically halving the reported U values. The revised value for the mean U content is 0.22 ppM for the microtektites studied and 0.7 ppM for the single tektite studied. (UK)

Oceanography

Refer also to abstract 51607.

51649 (A/CONF.49/P-457) RADIOACTIVITY OF OCEAN WATERS AND BEHAVIOR OF SOME FISSION PRODUCTS. Vdovenko, V. M.; Kolesnikov, A. G.; Spitsyn, V. I.; Bernovskaya, R. N.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, [Moscow]). Jun 1971. 32p. (CONF-710901-282). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The contamination of oceans by radioactivity due to fallout and waste disposal was investigated. The ^{137}Cs and ^{90}Sr contents of surface waters of the Atlantic and Pacific Oceans were measured during 1965 to 1970. It was found that the concentration of these isotopes decreased with time in the Pacific Ocean, but remained fairly stable in north Atlantic Ocean waters at latitudes of 20° and 40°. The ^{137}Cs and ^{90}Sr contents of deep ocean waters were measured and found to be markedly influenced by fallout. Some deep currents labeled with ^{90}Sr from waste disposal were found. The behavior of ^{144}Ce, ^{95}Nb, and ^{91}Y in the ocean was studied. The specific influence of seawater over the state of radionuclides was studied. In particular ^{91}Y has a considerable influence on the natural ligands and in the layers of large density gradients in a genuine-soluted state; as for the other samples of water about 60% of the element changes into the state of suspension. The biogenic and abiogenic processes of extraction of radionuclides from seawater were investigated. The abiogenic capture and the fixing of the radionuclides by suspension depends on the ocean suspension properties. Iron, as a biogenic element is shown to promote the involving of ^{144}Ce, ^{95}Nb, and ^{91}Y in plankton organisms, i.e., in the active biological cycle. The absorption of these nuclides by bottom sediments of the Indian and Pacific Oceans from seawater was studied. (L.C.L.)

51650 (A/CONF.49/P-646) SOME APPLICATIONS OF RADIOISOTOPES IN COASTAL POLLUTION CONTROL. Edens, J. J. May 1971. 18p. (CONF-710901-307). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Applications of radioisotopes in coastal pollution control have been a significant and successful part of the activities of the Danish Isotope Center. The most important field is the utilization of ^{82}Br (as NH_4Br) as a tracer in simulation of discharged sewage in the ocean. Other radioisotope methods are currently employed in water pollution studies, such as the primary production of organic matter is determined by the ^{14}C method, and mercury content in living organisms, sediments etc. is determined by neutron activation analysis. (D.H.M.)

51651 (A/CONF.49/P-850) RECENT WASTE MANAGEMENT PROGRAMME IN JAPAN AND THE STUDIES ON THE BEHAVIOR OF RADIONUCLIDES IN THE MARINE ENVIRONMENT FOR HAZARD EVALUATION OF SEA WASTE DISPOSAL. Saiki, M. (National Inst. of Radiological Sciences, Chiba (Japan)); Koyanagi, T.; Ohmomo, Y.; Ishikawa, M.; (and others) May 1971. 30p. (CONF-710901-351). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In order to cope with the rapid increase in the number of nuclear power stations to be expected in the near future in Japan, the establishment of a reprocessing plant for spent nuclear fuel has been planned with a target date for operation in 1973. Some of the low-level radioactive liquid wastes may be discharged into the sea. To clarify the various factors necessary for evaluating the hazard associated with the discharge of radioactive wastes into the sea, research was conducted on the following subjects: the behavior of radionuclides in the sea; sorption of radionuclides by marine sediments; investigation on biological concentration; and survey of the actual status of food consumption. The results of these investigations are introduced, together with a brief introduction of the recent status on the waste management program in Japan. (auth)

51652 ORIGIN OF THE PACIFIC MANGANESE NODULES BASED ON THE RADIOISOTOPE CONTENT. **Cherdyntsev, V. V.; Kadyrov, N. B.; Novichkova, N. V. (Geological Inst., Moscow). Geokhimiya; No. 3, 339-54(Mar 1971). (In Russian).**

In manganese nodules of the Pacific Ocean very large variations of Th/U ratios (from 0.28 to 47 weight units) were obtained. They correlate with ^{230}Th/^{238}U and Pa/^{235}U ratios. In/Th ratios on the contrary vary little from the average value of 1.3 activity units. An excess of ^{230}Th and Pa deposited from seawater, often exists in the crust of nodules. In most cases the content of ^{234}U is much less than the equilibrium one. In different layers of nodules large variations of radiochemical parameters exclude the possibility of absolute age determination, but these variations point to a young age. The maximum age may be determined in cases, when ^{230}Th/^{234}U or Pa/^{235}U ratios are lower than the equilibrium values. Sometimes this age does not exceed 17 to 18 thousand years. The results of radiochemical investigations show, that the nodules are formed from volcanic matter of abyssal type (deficient in ^{234}U and often enriched in thorium). This is undoubtedly true for some specimens with extremely high: (Pa/^{235}U) : (^{230}Th/^{238}U) ratios (reaching 6.0 ± 0.3). The content of uranium in volcanogenic nuclei of nodules is ten times as much as in the basalts of the Pacific Islands. (auth)

51653 SOME FEATURES OF THE TRANSPORT OF RADIOACTIVE CONTAMINATION IN THE OCEANS. **Belyaev, V. I.; Kolesnikov, A. G.; Nelepo, B. A. Tr. Morsk. Gidrofiz. Inst., Akad. Nauk Ukr. SSR; 42: 3-12(1969). (In Russian).**

Radioactive contamination in oceans is distributed by advection and three-dimensional turbulent diffusion. The factors involved include the concentration of the radioactive element, the flow rate vector, the turbulent diffusion coefficient and the decay constant of the radionuclide. The transfer of radioactive particles from the atmosphere—ocean interface to the bottom was examined, considering the 4 layers which play a role: the thin molecular surface layer, the upper active layer of the seawater, the thermocline, and depth layer. The particle may be deposited at the surface either directly or by raindrops. Formulas were derived to explain the existence of a turbulent layer. The results were compared with data obtained in similar studies of the Caribbean Sea and the south Atlantic Ocean. The literature data indicate that the ^{137}Cs/^{90}Sr ratio does not change in the seawater to a depth of about 2000 meters. It is emphasized that the concentration of radioisotopes in a given mass of water changes not only as the result of decay but also as the result of turbulent diffusion. The concentration of long-lived elements is determined with a relatively large error; therefore age determination of waters yields high values if the turbulent diffusion is not taken into account. (TTT)

Seismology

51654 (NVO-1163-225) CALCULATED COMPRESSIONAL WAVE ARRIVALS FROM UNDERGROUND NUCLEAR DETONATIONS. **Murphy, J. R. (Environmental Research Corp., Las Vegas, Nev.). May 1971. 66p. Dep. NTIS.**

Analytical expressions have recently been derived for the principal waves generated at a plane interface between two elastic solids due to a spherical compressional wave arriving at an arbitrary angle of incidence. These results are generalized to incorporate a nuclear seismic source function acting in a multilayered, linearly inelastic halfspace. Using a seismic source function and crustal model appropriate for the nuclear event Boxcar, the particle velocity profiles corresponding to those compressional wave types which are routinely identified on measured seismograms were calculated and compared with the observed data for this event. These comparisons indicate that the peak amplitudes of some important compressional wave types can be predicted with reasonable accuracy using a relatively simple model of the seismic transmission path. These initial results indicate the feasibility of calculating relative transmission path factors for Nevada Test Site (NTS) and off-NTS underground nuclear tests. (auth)

XUM

ENGINEERING

Nuclear Explosions

Refer also to abstracts 51364, 51617, 51618, 51654, 51711, and 51952.

51655 (A/CONF.49/P–144) PROSPECTS OF PEACEFUL APPLICATIONS OF NUCLEAR EXPLOSIONS IN THE UNITED ARAB REPUBLIC. El Guebeily, M. A.; El Shazly, E. M.; Diab, M. K. (Atomic Energy Establishment, Cairo (Egypt)). [May 1971]. 16p. (CONF-710901–82). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Possible applications of nuclear explosions in important development projects in the U.A.R. are described. Some of these have been studied by the concerned authorities for execution by conventional methods. The U.A.R. territory being more than 95% desert and generally geologically stable and seismologically calm possesses inherent potential for safe applications of nuclear explosions for desert development and realization of certain projects in desert environment. The following projects are included in this study: excavations in some 70 km topographically difficult ridges representing part of the main feeder intended to carry Nile waters from Lake Nasser to irrigate large areas covered with suitable soils in southern depressions of the Western Desert termed New Valley; excavating in the projected Mediterranean-to-Qattara canal system. The Qattara project implies transporting seawater from the Mediterranean through a 72 km canal and/or tunnel into the depression in the northern Western Desert and making use of the large difference in elevation to generate electric power. The depression occupies an area below sea level of 19,500 km^2 where the absolute level of the lowest point is 134 m below sea level; consideration of the Suez Canal development projects to meet the increasing size of oil tankers, the expected rise in oil transportation from the Arabian Gulf to Europe and general expansion of international trade; and other projects connected with mineral resources development, including creating cavities for gas and oil storage. A general evaluation of various important factors related to the possible applications of nuclear explosions in these projects will be given including reference to scientific and technical aspects, safety considerations, and as far as possible, comparative nuclear and conventional excavation costs. (auth)

51656 (A/CONF.49/P–762) REVIEW OF THE CURRENT STATUS OF CIVIL ENGINEERING AND MINERAL RESOURCES DEVELOPMENT APPLICATIONS OF PEACEFUL NUCLEAR EXPLOSIONS. Wilson, A. R. W. (Australian Atomic Energy Commission). Jul 1971. 21p. (CONF-710901–448). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Progress since the Third Geneva Conference in developing basic information for evaluating the technical feasibility, safety, and economic viability of proposed peaceful nuclear explosions is discussed on the basis of available experimental data. The ability to predict explosion effects and an understanding of safety factors are discussed. (D.H.M.)

51657 (AD–716601) EXTREMELY LOW FREQUENCY WAVES AND PROPAGATING IONOSPHERIC DISTURBANCES IN DETECTING ATMOSPHERIC NUCLEAR EXPLOSIONS. Report for December 1, 1969–November 30, 1970. Tolstoy, I. (Florida State Univ., Tallahassee). Contract F44620-69-C-0043. 32p. (AFOSR–70-2838-TR). NTIS.

A suitable Green's function model to explain the generation of long period, large amplitude gravity modes by thermonuclear and nuclear tests in the atmosphere is established. Thus, it is shown that the important mechanism here must be the rising sphere of hot gas. It is not difficult to demonstrate that, for large yields, at least, this mechanism should be orders of magnitude more efficient in generating long period internal gravity wave modes than the explosion phase proper. It is the belief now that this is the source of observed long wavelength gravity waves; although the principle of the mechanism is merely illustrated without extending the results to a realistic model of the atmosphere, there appears to be little doubt that one may in this manner account for the large amplitudes of vertical motion observed for such disturbances traveling in the ionosphere. (auth) (USGRDR)

51658 (AD–717090) FEASIBILITY STUDY OF NUCLEAR FIREBALL SIMULATION. Final Report. Baum, D. W.; Gill, S. P. (Physics International Co., San Leandro, Calif.). Nov 1970. Contract DASA01-69-C-0123. 46p. (PIFR–157; DASA–2543). NTIS.

The initial phase of an experimental program designed to assess the feasibility of simulating the thermal environment of a high-temperature nuclear fireball is described. A high-performance, explosively driven shock tube is used to produce temperatures from 10,000 K to 100,000 K in xenon gas. The Boltzmann number and optical depth in the gas are chosen to match the fireball environment. Radiative energy transfer dominates conductive and convective processes in a nuclear fireball (as measured by the Boltzmann number), so that it is possible to achieve fireball simulation with a gas other than air. Xenon was chosen for its thermodynamic compatibility with state-of-the-art explosively driven shock tubes. The fireball simulator is primarily useful in providing a definitive experimental test of prediction codes for fireball thermal effects, for obtaining data on the energy-transport properties of ablated surface materials, and for developing and testing fireball instrumentation concepts. (auth) (USGRDR)

51659 (AD–720853) INVESTIGATION OF ATMOSPHERIC PRESSURE WAVES FROM NUCLEAR EXPLOSIONS. Final Report, December 1–November 30, 1970. Herron, Thomas J.; Donn, William L. (Columbia Univ., Palisades, N. Y. Lamont-Doherty Geological Observatory). 20 Jan 1971. Contract F44620-70-C-0019. 51p. (AFOSR-TR–71-613). NTIS.

Atmospheric gravity waves generated by low-altitude nuclear explosions have been detected by ground-level microbarographs and by ionospheric instruments. Group velocity dispersion curves were computed for propagation over the short and long great-circle paths. Apparent lower velocities over the short paths are interpreted as due to the rise time of the nuclear disturbances to ionospheric levels with subsequent generation of gravity waves at those levels. Corrections to travel times to account for the rise time delays are estimated to be about 13 min or more. Corrected group velocity dispersion curves are found to agree with theoretical group velocity dispersion for atmospheric surface waves. The spatial coherence of 1 to 5 min acoustic waves from two nuclear explosions is presented along with atmospheric pressure background noise for the same period band. The spatial coherence of the waves from both explosions is greater than the noise coherence at station separations greater than 6 to 10 km. (auth) (USGRDR)

51660 (CONF-710428–, Paper 2) PROJECT RULISON: A NEW APPROACH TO THE ENERGY SHORTAGE. Leisk, C. Wardell (Austral Oil Co., Inc., Houston, Tex.). 6p.

From Conference on innovative applications of radiation; Dallas, Tex. (22 Apr 1971).

In Conference on innovative applications of radiation.

The story of Project Rulison, a joint undertaking by Austral Oil Company, Incorporated and the Atomic Energy Commission within the framework of the Plowshare Program, is presented. The purpose of the project is to determine the technical and economic feasibility of employing nuclear stimulation for the release of natural gas from tight formations. (D.H.M.)

51661 (NVO–103) REPORTS AVAILABLE IN THE ALASKAN INFORMATION PROGRAM. (Nevada Operations Office (AEC), Las Vegas). 30 Jun 1971. 9p. Dep. NTIS.

Since the U. S. Atomic Energy Commission (AEC) selected Amchitka Island, Alaska, as a location for higher-yield underground nuclear tests, the Nevada Operations Office (NVOO) of the AEC has conducted a continuing program to acquaint the public with (1) the facts of the test program, and (2) the measures being taken to assure the safety of the public and test participants, as well as assuring the protection of the environment. As a part of this overall program, the NVOO has established "open file" depositories in Alaska at which unclassified scientific and technical reports relating to the AEC's Amchitka Island activities are readily available to the public. The purpose of this brochure is to list those documents that have been provided to the open files. (auth)

51662 (SC-RR-710056) AIRBLAST FROM PROJECT TRINIDAD DETONATIONS. Vortman, L. J. (Sandia Labs., Albuquerque, N. Mex.). Jun 1971. 223p. Dep. NTIS.

Airblast was measured from distances of a few hundred feet to about six miles from single one-ton surface, near surface, and buried explosions. Similar measurements were made perpendicular to and off the ends of buried single row-charges detonated simultaneously and with delays between charges in the rows, and buried double-row charges detonated simultaneously and with delays between rows. Explosives were either ammonium nitrate and fuel oil or aluminized ammonium nitrate slurry. Single charges detonated at and near the surface gave peak overpressures and impulses close to those of TNT charges burst similarly. Buried single charges had positive impulses comparable to those from TNT, but had ground-shock-induced peak overpressures about twice those of TNT, and gas-venting peak overpressures from two to eight times those of TNT. A one-ton charge placed at the bottom of a 14-inch-diameter unstemmed hole produced overpressures and airblast energy about midway between an equivalent surface burst and a completely stemmed explosion at the same depth. Waveforms from all row-charge detonations were complex, and neither peak overpressures nor positive impulses could be related consistently to those from single charges or to smaller buried TNT charges in a more uniform medium. No airblast damage occurred at either Jansen or Trinidad, Colorado at a maximum peak overpressure of 0.009 psi. (auth)

51663 (UCRL–51067) GAS QUALITY AT THE WELLHEAD: PREDICTIONS FOR PROJECT WAGON WHEEL. Tewes, H. A.; Taylor, R. W. (California Univ., Livermore. Lawrence Radiation Lab.). 20 Jul 1971. Contract W-7405-eng-48. 10p. Dep. NTIS.

Results and inferences from the Gasbuggy and Rulison experiments are used to predict gas quality for Project Wagon Wheel: five 100-kt explosives in a single emplacement hole, at an average depth of approximately 10,000 ft in sandstone. The calculations cover nuclide production, total anticipated gaseous radioactivity, distribution of the radioactivity, and chemical composition of the chimney gas. Data support a critical dependence of the radioactivity distribution and chemical composition on the chimney gas temperature. Conclusions are based on premises about the Wagon Wheel geometry, such as the spacing of the explosives, and certain data from Gasbuggy and Rulison which are still being evaluated. (auth)

51664 (UCRL–72769(Rev.1)) UNDERGROUND ENGINEERING APPLICATIONS, CONCEPTS, AND EXPERIENCE. Nordyke, Milo D. (California Univ., Livermore. Lawrence Radiation Lab.). 15 Dec 1970; Revised 10 Feb 1971. 61p. (CONF-710108–1). Dep. NTIS.

From second panel on the peaceful uses of nuclear explosions; Vienna, Austria (18 Jan 1971).

Industrial applications of underground nuclear explosions are discussed. These applications include natural gas production stimulation, in-situ copper leaching, geothermal heat recovery, and excavation of deep-underground radioactive waste repositories. Experience and data gained from the Gasbuggy and Rulison Events are examined in detail and evaluated. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 51732, 51752, 51784, 51801, 52102, 52489, 52761, 52952, and 54102.

51665 (A/CONF.49/P–152) IRRADIATION FACILITIES: THEIR IMPORTANCE IN DEVELOPING CANADIAN NUCLEAR COMPETENCE. Mooradian, A. J. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment); Perryman, E. C. W. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.); Kennett, T. J. (McMaster Univ., Hamilton (Ontario)). May 1971. 14p. (CONF-710901–171). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Canadian nuclear program was born over 25 years ago and has now matured as a national industrial activity. Over this interval the program has been characterized by the development of research reactors which span the spectrum from zero-energy facilities to large test reactors capable of accepting full-size prototypes of power reactor fuels and other components. Experience indicates that the design, construction and use of such facilities have the following important advantages: they force a close interaction between scientists, engineers and operators; they force the development of the many skills needed to support an expanded nuclear program; they help to train consultant, utility, industrial and regulatory personnel; they put in context the size of the task of developing a domestic nuclear industry; and they benefit non-nuclear segments of industry, and the country's educational, medical and environmental programs. Specific examples illustrate these advantages. In addition, the financial and manpower resources to prosecute such programs are discussed. (auth)

51666 (A/CONF.49/P–589) METHOD FOR THE ECONOMIC STUDY OF THE BENEFITS OF DESALINATION IN SATISFYING THE NEED FOR WATER. Thiriet, L.; Libert, J. J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires); Lambert, J. (SOFRED, Paris (France)). Jul 1971. 13p. (CONF-710901–442). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Any study of the use of desalination techniques to meet water requirements involves comparing the various desalination processes (as defined by their cost structures and economies of scale) with conventional water supply methods against a background of generally increasing demand. When requirements and resources in a given area and how these vary over a period of time have been examined in detail, it is essential to have a coherent overall method of assessing the economics of using desalination to meet estimated requirements, particularly with an eye to the possibilities offered by nuclear energy. Such a general method (of dynamic programming) enabling the question of the optimal sizing of desalination facilities to be resolved, and bearing in mind economies of scale and possible storage facilities, is presented. The optimum lives of the facilities are determined. This enables the rigorous comparison in terms of economics of the various alternatives. The method is illustrated by some examples of application. (auth)

51667 (A/CONF.49/P–636) PROGRESS IN RADIATION PROCESSING IN FRANCE. Puig, Jean R. (Centre d'Application et de Promotion des Rayonnements Ionisants, Saclay (France)); Gaussens, Gilbert; Laizier, Jacques (Centre d'Application et de Promotion des Rayonnements Ionisants, Corbeville (France). Ste de Recherches Techniques et Industrielles). Jul 1971. 21p. (CONF-710901–446). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Radiation processing in France is growing rapidly while new processes are being developed by industrial firms, in partnership with CAPRI in a number of cases. Radiation service is supplied by companies mainly for sterilizing medical articles. Radiation produced heat-shrinkable films and tubing are being manufactured. Radiation graft copolymerization is used to yield modified polymers and an adhesive type of polyethylene made in this way is undergoing extensive market evaluation. The French radiation industry is described in terms of size and growth. The growth rate has been about 60% per year for the last four years. The radiation industry has better development opportunities due to the support provided by the CAPRI laboratories which started operating about a year ago. Industrial firms can find at CAPRI the possibility of undertaking research and development work they could not carry out on their own for financial reasons. (auth)

51668 (A/CONF.49/P–804) MULTI-PURPOSE IRRADIATION PLANT AND THE QUALITY CONTROL OF RADIATION STERILIZATION OF MEDICAL EQUIPMENT. Christensen, Ebbe A. (Statens Seruminstitut, Copenhagen (Denmark)); Holm, Niels W. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jun 1971. 20p. (CONF-710901–432). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The large investment required for setting up an industrial service irradiation plant makes it desirable that it should be possible to use the plant for more than a single purpose. Commonly occurring activities with a service irradiator may comprise a wide variety of processes, such as sterilization of medical supplies, germ reduction in pharmaceutical raw materials or intermediate products, sprout inhibition in potatoes and onions, and radiation-chemical processing. The design requirements of future multipurpose irradiation facilities, particularly those whose services include sterilization of medical supplies, are discussed. It is concluded that multipurpose irradiation plants are feasible. Plant design suggestions for a ^{60}Co-source facility and an electron accelerator facility are presented. (L.C.L.)

51669 (A/CONF.49/P–812) TEST LOOP FOR GENERATORS OF HOT SODIUM VAPOR (C.G.V.S. 50 MW(th)). Milliat, J. P.; Beaufrere, J.; Chanudet (Electricite de France, Paris); Menez, A.; Charbonnier, J. C.; (and others) May 1971. 12p. (In French). (CONF-710901–338). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The principal problems encountered in the construction of a 50 MW test facility are discussed, such as special operating conditions, capabilities required for permanent operation and transient tests (temperature transients and flow), arrangements to ensure safety (in case of sodium–water reactions for instance), original aspect of the studies (thermal balances, dynamic analysis, and control). A description of the main events that occurred during the testing period and after July of the first year of operation makes it possible to ascertain the origin of the various incidents and their remedies. (auth)

51670 (AEEW-M–1000) ESTIMATION OF TUBE WALL TEMPERATURES IN THE EVAPORATOR REGION OF SUBCRITICAL

XUM

ONCE-THROUGH SODIUM HEATED STEAM GENERATORS. Bailey, N. A.; Collier, J. G. (Atomic Energy Establishment, Winfrith (England)). Aug 1970. 18p. Dep. NTIS (U. S. Sales Only). UK 20p.

The available information on the magnitude of the surface temperature rise resulting from dryout in a highly rated subcritical once-through steam generator and the influence of such parameters as heat flux, mass velocity, pressure and tube diameter are reviewed. A method is proposed whereby the water side heat transfer characteristics determined using electrically heated tubes may be used to estimate the variation in tube wall temperature in a sodium-heated steam generator, and the uncertainties involved just downstream are discussed. (auth)

51671 (LA-DC-12533) VERSATILE CONTAINMENT BOX SYSTEM. Moore, Philip F. (Los Alamos Scientific Lab., N. Mex.). [1971]. 9p. (CONF-711008-2). Dep. NTIS.

From nineteenth conference on remote systems technology; Miami, Fla. (17 Oct 1971).

As a better solution than the former practice of custom building containment boxes for each new use, a system has been developed to take advantage of the economies of quantity production and the stocking of standardized re-usable components. A basic shell may be assembled with an assortment of different components to configure it for a particular use. A contaminated box may be disassembled and the individual components cleaned separately to a degree sufficient to prepare them for re-use. A box assembled from these re-used parts has then become, for practical purposes, a new box at a fraction of the cost of a newly fabricated box. (auth)

51672 (LA-DC-12753) DIFFERENTIAL THERMAL ANALYSIS APPARATUS FOR OBSERVATION OF IRRADIATED Pu-CONTAINING REACTOR FUELS. Reavis, J. G.; Brewer, G. R.; Court, D. B.; Schulte, J. W. (Los Alamos Scientific Lab., N. Mex.). [1970]. 16p. (CONF-711008-3). Dep. NTIS.

From nineteenth conference on remote systems technology; Miami, Fla. (17 Oct 1971).

A differential thermal analysis apparatus for observation of melting points and other phase transformations of irradiated fuel materials has been constructed in the Wing 9 Hot Cell Facility of Los Alamos Scientific Laboratory. Photosensitive detectors and optical pyrometry are used to measure temperatures of thermal effects in samples. Melting points and transformation temperatures of Pt, Pt–C eutectic, Ir, Mo–C eutectic, ZrO_2, UO_2, and UC_2, were observed in order to determine temperature corrections to be used because of light absorbtion by the shielding window. Irradiated samples of UO_2–PuO_2 fuel materials were observed in sealed tungsten capsules. (auth)

51673 (LMEC-Memo-70-20) TEST AND EVALUATION OF ALCO/BLH PROTOTYPE SODIUM-HEATED STEAM GENERATOR (FINAL REPORT). Kaplan, C. J.; Auge, L. J.; Cho, S. M.; Hanna, R. W.; Prevost, J. R.; Steger, N. A.; Wagner, R. K. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). 31 Jan 1971. Contract AT(04-3)-700. 371p. Dep. NTIS.

As a part of the Liquid Metal-Cooled Fast Breeder Reactor program, a 30-Mw(t) prototype sodium-to-sodium intermediate heat exchanger and a 30-Mw(t) prototype sodium-heated steam generator in combined operation were tested. The results of test and evaluation of the steam generator are presented. The steam generator is a once-through design in which water/steam flows vertically upward in tubes, being heated by sodium flowing downward on the shell side. During plant performance tests, performance degradation was observed, which resulted in the initiation of a diagnostic test series. This test series revealed that under certain operating conditions, the thermohydraulic characteristics of the steam generator changed either suddenly or gradually, resulting in overall performance degradation. A structural failure, requiring retirement of the unit, occurred before the diagnostic test series and analytical support effort were completed. The thermohydraulic and structural performance, including the structural failures, and related evaluation analyses of the prototype steam generator performed prior to termination of the test and evaluation program are described. In addition, a post-test examination plan to obtain data that could possibly explain the cause of performance anomalies and structural failures experienced during testing is presented. (auth)

51674 (NASA-SP-5938-1) FLUID TECHNOLOGY (SELECTED COMPONENTS, DEVICES, AND SYSTEMS). A Compilation. (National Aeronautics and Space Administration, Washington, D. C.). 1970. 15p. NTIS $1.00.

Descriptive summaries are presented on fluid components, devices, and systems. The items discussed may be of interest to designers and manufacturers of hydraulic and pneumatic components, fluid filtration systems, fluid calibration systems, other fluid devices, and pyrochemical devices. (J.R.D.)

51675 (WCAP-4167-1, pp 5.1-58) DEMONSTRATION ASSEMBLY FABRICATION. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.).

In EEI-Westinghouse plutonium recycle demonstration program.

The objective of this portion of the program is to fabricate 734 mixed-oxide fuel rods and 16 UO_2 replacement fuel rods as part of the EEI-Westinghouse Plutonium Recycle Demonstration Program. The scope includes all operations required for receipt of plutonium nitrate solution; conversion to plutonium oxide or mixed-oxide; blending to the desired mixed-oxide composition, pellet fabrication, rod fabrication and inspection, recovery, purification and recycle of process scrap, and treatment of waste solids and solutions for disposal. All process steps in the fabrication program were demonstrated with no major problems and, as of April 1970, all required fuel rods were fabricated and inspected. Direct recycle of clean scrap materials was demonstrated as part of the pellet fabrication studies. Work also was initiated on the recovery of Pu from both chemically-contaminated material and from excess clean scrap material. The facility is licensed by the AEC to process up to 60 kg of Pu for thermal reactor fuel development. The ability to safely operate such a facility under a quasi-production status was demonstrated. A safeguards and accountability system was established to assure control of all nuclear material within the facility. The effectiveness of this system was demonstrated by several physical inventories. (auth)

51676 PROBLEMS IN THE UTILIZATION OF OIL PRESSURE IN NUCLEAR POWERED SHIPS. EFFECT OF RADIOACTIVITY ON HYDRAULIC DEVICES. Omori, Norihiko (Mitsubishi Atomic Power Industries, Inc., Tokyo). Yuatsu Gijutsu; 9: No. 6, 76-80(Jun 1970). (In Japanese).

The advantages of utilizing oil pressure for driving mechanical devices in a primary coolant system of a nuclear reactor plant are reviewed, in connection with the involved radioactivity. Two examples are cited. Oil pressure is used in the control-rod drive in N.S. Savannah: In the ship, oil pressure is used for scramming the reactor with the control rods. The pressure in a cylinder is increased by pressing down a driving piston with the pressure stored in an accumulator. Nitrogen gas is sealed in each accumulator to reduce and monitor oil leakage. Oil pressure is used to open or close the door in the secondary shield in the first nuclear-powered ship in Japan, Mutsu. This door is operated by means of hinges, with an oil pressure cylinder. The oil-pressure circuit is an ordinary one. (Japan)

51677 RECENT STATE OF THE PUMPS FOR ATOMIC ENERGY. Matsui, Hiroo (Ebara Mfg. Co. Ltd., Tokyo). Ponpu Kogaku; 6: 240-6(Apr 1970). (In Japanese).

With the advance in nuclear power generation, a variety of pumps, principally centrifugal, has been put to use in recent years. The following pumps used with BWR's and PWR's are described: coolant circulation and feedwater pumps for removing heat from the reactor core; auxiliary pumps, including those for coolant purification and control drive; and safety pumps such as for high-pressure injection and reactor-core spray. Liquid sodium circulation pumps of two types are used, namely, electromagnetic and centrifugal pumps. The latter is used for main circulation. The centrifugal pumps are either shaft sealed or canned-rotor type. Cooling or electromagnetic methods are employed for sealing liquid sodium. Finally, a centrifugal pump with free liquid metal surface, filled with inert gas, is described. (Japan)

51678 PERFORMANCE AND APPLICATIONS OF AN ELECTROMAGNETIC ROTARY-FLOW DEVICE IN LIQUID SODIUM. Hayes, D. J.; Baum, M. R.; Hobdell, M. R. (Central Electricity Generating Board, Berkeley, Eng.). J. Brit. Nucl. Energy Soc.; 10: 93-8(Apr 1971).

The design of a purpose-built demountable electromagnetic stator for generating rotary flow in liquid sodium is described. Qualitative results of its performance at 130 and 350°C sodium temperatures are presented. Potential applications include the centrifuging of sodium for gas or particulate removal; these and other applications are briefly discussed. (auth) (UK)

51679 GAS TURBINE INSTALLATION. (to Siemens Aktiengesellschaft). British Patent 1,229,943. 28 Apr 1971. Priority date 26 Aug 1967, Germany.

A gas turbine suitable for use with CO_2-cooled reactor includes a fluid circuit including the heat source and a compressor–turbine set. The installation is operable in a normal mode with the gaseous fluid under such conditions that it is substantially incompressible. Means are provided so that the installation can be changed over to a further mode for emergency cooling or after-cooling of the heat source in which the compressor is arranged to provide a substantially increased speed of flow of the gaseous fluid at such a reduced pressure that it behaves substantially as an ideal gas. The after-heat from the heat source, after it has been shut down, is utilized to drive the compressor–turbine set in the further mode. (B.L.M.)

51680 IRRADIATION APPARATUS. Eymery, Rene (to Commissariat a l'Energie Atomique). British Patent 1,238,565. 7 Jul 1971. Priority date 23 Oct 1968, France.

An irradiation apparatus in which substances are exposed to radiation as they pass in front of a radioactive source is made up of a generally planar radioactive source comprising a number of radioactive elements disposed in spaced relation and a mask having apertures in it related to the radioactive elements and extending adjacent and parallel to a face of the source. The mask comprises screen portions at least in part defining the apertures. Each screen portion has a transverse cross section, which decreases in a direction away from the source. (B.L.M.)

51681 INSULATING VESSEL FOR ANALYZING MATERIALS IMMERSED IN VARIOUS MEDIA. Allain, Albert; Farny, Gerard (to Commissariat a l'Energie Atomi que). French Patent 2,029,205. 5 Oct 1970. Filed 17 Jan 1969. (In French).

A special type of insulated vessel was developed for analyzing materials immersed in different media. A vessel of this type was used in the analysis of irradiated materials inside a pool, the analysis of an irradiated in-pile device by neutronography being of particular interest. The vessel consists of a sealed chamber with an orifice for introducing the material to be analyzed, and a freezing coil acting on the fluid traversing the orifice and effecting its closure. The system incorporates a means of evacuating the chamber closed by the frozen fluid. (France)

51682 SAMPLE HOLDER FOR AN INDUCTION IRRADIATION FURNACE. Briand, Alain (to Commissariat a l'Energie Atomique). French Patent 2,036,155. 14 Dec 1970. Filed 5 Mar 1969. (In French).

A sample holder for an induction oven is described. It consists of a diffuser, made of a material which does not appreciably absorb neutrons, but nevertheless has a good thermal conductivity. Inside this diffuser, an enclosure for the samples to be irradiated is provided. An external can, made of a different material, which also does not absorb neutrons surrounds the diffuser. Its resistivity is matched to the requirements necessitated by the frequency of the oven. The can fixes traces of corrosive gases existing or produced in the sample holder. (France)

51683 EXPERIMENTAL MOBILE AUTOMATON. Rosen, Charles A. (Stanford Research Inst., Menlo Park, Calif.). pp 196-203 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

A program of research in machine intelligence has been underway at the Stanford Research Institute for the last five years. A complete system has been successfully developed to integrate a test robot with computer programs. The system has demonstrated autonomous behavior. The program also produced an insight into the key problems remaining and the relative effort required for their solution. Future research will be carried out to find better computer methods, improve sensory perception and feedback, add to artificial intelligence techniques, and improve the hardware. (auth)

51684 IRRADIATION AT 20°K IN TRITON REACTOR. Bull. Inform. Sci. Tech. (Paris); No. 153-154, 66-74(Nov-Dec 1970). (In French).

The irradiation system is composed of a Philips cryogenerator PPH-110 mounted on a carriage to which a nitrogen cryostat is fixed. The cryogenerator and cryostat are described; the performances and results obtained in a flux of thermal neutrons, particularly in measuring the length and resistivity variations, are given. In order to satisfy the requirements for low temperature irradiation, a study on the positioning, safety, and working conditions of low temperature loops was made. (France)

Heat Transfer and Fluid Flow

Refer also to abstracts 51636, 51670, 51828, and 51829.

51685 HEAT TRANSFER AND FRICTION IN TUBES WITH REPEATED-RIB ROUGHNESS. Webb, R. L. (Trane Co., La Crosse, Wis.); Eckert, E. R. G.; Goldstein, R. J. Int. J. Heat Mass Transfer; 14: 601-17(Apr 1971).

Heat transfer and friction correlations are developed for turbulent flow in tubes having a repeated-rib roughness. The friction correlation is based on law of the wall similarity. The heat transfer correlation is based on application of a heat–momentum transfer analogy to flow over a rough surface. The correlations are verified with experimental data taken with $0.01 < e/D < 0.04$ and $10 < p/e < 40$, and covering the range $0.71 < Pr < 37.6$. The correlations may be extended to a wider range of e/D by virtue of the law of the wall. The good results obtained in this study, supported by prior work with sand-grain roughness, offer strong argument for application of the correlating methods to other roughness geometries. The success of the heat-momentum analogy correlation is compared with other methods frequently found in the literature. (auth) (UK)

51686 VELOCITY MEASUREMENT WITH RADIOACTIVE SPHERES. Yen, Ben Chie; McGillivray, Terrence L. (Univ. of Illinois, Urbana). Water Resour. Res.; 6: 609-13(Apr 1970).

Experimental evidence shows that the use of radioactive spheres as a flow velocity tracer is feasible. The technique involves trapping a small amount of radioisotope inside a sphere and then measuring the motion of the sphere in the flow. For steady uniform subcritical turbulent flows tested with the Reynolds number up to 13,000 and the flow depth to sphere diameter ratio greater than 1.7 the accuracy of flow velocity measurement with floating tracers is usually within ±7%. The accuracy can be improved if the correction for the relative velocity between the fluid and the sphere is made. The advantages of this technique are its simplicity, its relatively small contamination problem, its low cost, and its potential to be used in a wide range of flow conditions. (auth)

51687 APPROACH TO THE ANALYSIS OF TEMPERATURE FLUCTUATION IN TWO-PHASE FLOW. Jovanovic, Lj.; Afgan, N.; Stefanovic, M. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). Bull. Boris Kidric Inst. Nucl. Sci., Nucl. Eng.; 21: No. 3, 21-8(Dec 1970).

The temperature fluctuation measurements in two-phase system were analyzed. Assuming that the temperature is a random variable, the resulting measurements of the temperature fluctuation in two-phase system can be divided in two independent fluctuation functions. The statistical results obtained in the analysis were compared with the measurements and fair agreement was found. (auth)

51688 VOID FRACTION AND STABILITY OF NATURAL CIRCULATION WATER BOILING IN A VERTICAL ANNULUS HEATED INTERNALLY. I. AXIAL PHASE AND AMPLITUDE DISTRIBUTION OF VOID FRACTION WITH UNIFORM HEAT FLUX. Dijkman, F. J. M. (Eindhoven Univ. of Tech., Netherlands). Nucl. Eng. Des.; 15: 77-89(Mar 1971).

Void fraction and inlet flowrate in a natural circulation boiling water loop were analyzed in terms of their relative dependence. Power spectra were calculated by means of a special-purpose analogue computer. The independent variables were channel power and inlet subcooling. Increasing power beyond certain values generated spontaneous hydraulic oscillations. The experiments covered both stable and unstable behavior of the system. The amplitude of the signals indicated an obvious transition between both regions, but the relative phases did not change. No rapid change of phase between any two signals was observed. Knowledge of the phase offered the possibility of calculating void propagation velocities. The results affirmed the physical inconsistency of a boiling boundary. (auth)

Isotope Technology

Refer also to abstracts 51303, 51381, 51382, 51606, 51609, 51612, 51615, 51627, 51630, 51686, 51733, 51852, 51864, 52072, 52149, 52364, and 53442.

51689 (A/CONF.49/P–6) USE OF RADIOISOTOPE X-RAY TECHNIQUES IN THE PAPERMAKING PROCESS AND QUALITY CONTROL MEASUREMENTS. Kuusi, J. (Helsinki Univ. of Tech., Otaniemi (Finland). Reactor Lab.); Puolakka, H. May 1971. 28p. (CONF-710901–61). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Progress towards higher production rates and a higher quality of products and the increasing application of computer controls to papermaking processes constantly call for more specific and more varied information on the process and require more sophisticated measuring methods and instruments. To a certain extent, these requirements may be met using radioisotope x-ray techniques because these techniques make it possible to carry out some important measurements for process and quality control which are difficult or impossible using other methods. The potential use of radioisotope x-ray techniques in the papermaking process and quality control measurements is reviewed, and a project for

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developing radioisotope x-ray instruments and methods for this purpose is described. (auth)

51690 (A/CONF.49/P-107) APPLICATION OF ISOTOPES AND RADIATIONS IN THE PEOPLE'S REPUBLIC OF BULGARIA. Andreev, E. (Viss Medicinski Inst., Sofia (Bulgaria)); Stoilov, M.; Piscov, I. May 1971. 12p. (In French). (CONF-710901-484). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The uses of radioisotopes and irradiation techniques in Bulgaria are discussed and include: medical research and therapy; studies of genetic irradiation injuries; tracer studies of the movement and accumulation of phosphates and nitrates in soils, plants, foods, and animals; irradiation effects studies of plant mutations; and measurement and control systems for industrial processes. (L.C.L.)

51691 (A/CONF.49/P-287) LARGE SCALE PRODUCTION OF ^{227}Ac AND DEVELOPMENT OF AN ISOTOPIC HEAT SOURCE FUELLED WITH Ac_2O_3. Baetsle, L. H.; Dejonghe, P.; Demildt, A. C.; (and others) (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). May 1971. 16p. (CONF-710901-106). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The irradiation devices and hot cell facilities including a radon absorption facility adapted for work with large quantities of ^{226}Ra and the resulting amounts of ^{227}Ac and ^{228}Th have been completed and put into operation during the last quarter of 1969. The first irradiation took place in November 1969 and after several months of adaptation and improvement of the installation, routine production has now been started. A production of the order of 20 to 30 g ^{227}Ac per year is possible in the existing facilities in the near future. A double containment, during irradiation in BR2, is ensured by putting the welded capsules in an aluminum rig (thimble) connected to a suitable instrumented control panel. Three hot cells have been fitted out with chemical equipment for precipitation, ion exchange techniques, and handling of oxide powders. Three other hot cells are installed to fabricate and test the heat source. A prototype heat source of 30 Watts to test fuel and capsule behavior and the venting system is now in preparation. (auth)

51692 (A/CONF.49/P-325) NEW TRENDS IN THE INDUSTRIAL APPLICATION OF RADIOACTIVE ISOTOPES IN HUNGARY. Foeldiak, G. (Magyar Tudomanyos Akademia, Budapest); Kocsis, F. (Ministry of Building and Urban Development, Budapest); Varro, K. (Ministry of Metallurgy and Machinery, Budapest). May 1971. 19p. (CONF-710901-111). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The industrial use of radioisotopes represents, in many cases, the most successful means of technical development. Geophysical and industrial measuring equipment (checking liquid level, surface weight, hydrogen content) and analog control systems, e.g., for complex processes in aluminum rolling mills, in plastic leather production, and in ore mixture and coke dosage systems in blast furnaces have been employed for several years. Moreover, third generation, integrated circuit digital instruments for system control with computers are being installed more and more frequently, e.g., in the production of high-pressure vessels. The role of computers in the supervision of industrial processes and facilities is also gaining in importance. By means of our computer programs it became possible to measure the relative activities of samples automatically, on a predetermined schedule, and to arrive at data with computers in a short time. Investigations which can be accomplished with simpler methods, e.g., detection of leakage, clogging, wear, corrosion, are also growing in favor. Computers are also used for mapping dose rate distribution of complex large irradiation facilities, in order to interpolate data obtained by physical and chemical dosimetry. These computer programs can also be used for planning irradiators for commercial sterilization: optimization renders it possible to achieve the same integral dose rates with lower activity sources. The application of point-like sources in radiography and in certain cases of neutron relays instead of gamma-relays aims also at the lowering of activity and thus lowering the costs of the isotope and those of the shielding. The industrial application of radioisotopes thus has left the stage of research and development and has become practical on a large scale. Isotopic methods, e.g., activation and other nuclear analyses and radiation processing, are gaining ground in the chemical and biological processes of industry. (auth)

51693 (A/CONF.49/P-334) PROGRESS IN APPLICATION OF NUCLEAR TECHNIQUE IN GEOPHYSICS, MINING, AND HYDROLOGY IN POLAND. Czubek, J. A. (Institute of Nuclear Physics, Krakow (Poland)); Florkowski, T.; Niewodniczanski, J.; Przewlocki, K. (Institute of Nuclear Techniques, Krakow (Poland)). May 1971. 28p. (CONF-710901-114). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Nuclear methods used in Poland in geophysics, hydrology, and mining include nuclear well logging, radiometric methods for analysis, and radioactive tracer techniques. Field applications of gamma and neutron well logging are discussed and include borehole determination of ash content in brown coal, iron in iron ore, evaluation of clay in sulfur deposits, "in-situ" determination of lead content in lead-zinc mine, etc. New applications in the mining and processing of coal and ores were demonstrated. Hydrotransport of sand and rock for back fill processes can now be fully controlled by radiometric methods measuring density, velocity of different fractions of solid phase etc. Deposited back fill parameters such as drying rate, changes in bulk density, anisotropy can be controlled by gamma and neutron probes with high accuracy. The x-ray fluorescence method was used in the field for evaluating copper deposits and also in ore-plant laboratories for routine analysis (zinc-lead ores). The method was also applied in field and laboratory for determining iron in ores, zircon in sands etc. In hydrology radioactive tracer methods were used for investigating leakage from water reservoirs. Single-well and multi-well techniques are in routine field use for studying leakage rates or measurements of effective porosity and tightness of underground water screens. Use of data on concentration of environmental isotopes present in natural waters for identification of various water bodies in connection with leakage studies or mining process has also started. (auth)

51694 (A/CONF.49/P-382) OBJECTIVES AND PROGRESS IN THE CENTRIFUGE ENRICHMENT PLANT INDUSTRY. Bogaardt, M.; Einfeld, K.; Tatlock, J. May 1971. 6p. (CONF-710901-207). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The organization, economic target, development and design, construction, and future prospects of the uranium centrifuge enrichment plant and process undertaken by the Netherlands, German, and British Governments are discussed. By this agreement, the three Governments promoted the formation of two commercial companies which, under the supervision of a Joint Committee of Government representatives, will exercise commercial freedom and act according to commercial standards of profitability. The concepts of the commercial exploitation of the gas centrifuge process under this agreement are listed. (P.C.H.)

51695 (A/CONF.49/P-383) SEPARATION NOZZLE PROCESS FOR ENRICHMENT OF ^{235}U. Becker, E. W.; Bier, W.; Ehrfeld, W.; (and others) (Karlsruhe Univ. (West Germany)). Apr 1971. 16p. (CONF-710901-134). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The separation nozzle process is based on pressure diffusion in a UF_6/He or UF_6/H_2 jet flowing along a curved wall. At Karlsruhe (Fed. Rep. of Germany) a ten stage pilot plant has been working successfully since November 1967. A full scale separating stage with a capacity of 1700 kg per year was built and is in permanent use for testing different types of separating elements. The construction of this stage is described. Calculations based on preliminary tenders of industry indicate that specific investment costs of separation nozzle plants will be considerably less than costs of diffusion plants of equal capacity. In the present state of development the specific energy consumption is still higher by a factor of approximately 1.6 as compared to the diffusion process. However, current theoretical and experimental studies of the separation nozzle effect show that a considerable reduction of the specific energy consumption is within the realm of possibility. In March 1970 Gesellschaft für Kernforschung, Karlsruhe, and STEAG, Essen, signed a contract on cooperation in the separation nozzle process. It is the purpose of this cooperation to provide further development, industrialization, and practical application of the process. All preconditions for starting the construction of a plant working economically with a separation capacity of 500,000 to 1,000,000 kg are expected to be given at the latest in 1974. The main features of such a plant are discussed. (auth)

51696 (A/CONF.49/P-455) NUCLEAR RADIATION FOR AUTOMATIC SORTING OF ORES. Kovda, G. A.; Skrinichenko, M. L.; Tatarnikov, A. P.; Koshelev, I. V.; (and others) (Akademiya Nauk SSSR). Jun 1971. 27p. (CONF-710901-281). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Practical uses of nuclear radiation for the automatic sorting of ores are described. The basic feature of the automatic ore sorting methods described is the rapid measurement of the intensity of natural or induced ionizing radiation or the intensity of a nuclear particle flux. This measurement permits one to determine with reasonable accuracy the content of the useful component in individual ore pieces. As a result of these measurements, ore pieces (batches) can be mechanically separated into the concentrate, tailings, and other products. The basic characteristics and parameters of both the equipment used and the material sorted and the effects of these parameters on the sorting accuracy are discussed. General conditions and fields of application are described. (L.C.L.)

51697 (A/CONF.49/P–465) USE OF RADIOISOTOPE DEVICES IN PROCESS MONITORING AND CONTROL. Emelyanov, V. A.; Kreyndlin, I. I.; Pugachev, A. V.; Yanushkovskii, V. A. (State Atomic Energy Committee, USSR). Jun 1971. 16p. (CONF-710901–391). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Radiometric equipment and methods have found wide use in industrial production process and agricultural research in the USSR due to the development of low-activity radioisotope-source instruments which have high sensitivity, fast response, and reliability of operation. Uses of radiometric instruments in the metallurgical industry are discussed and include automatic process control in steel making, monitoring and control of rolled metal thickness, regulation of liquid metal levels, etc. In the paper industry radiometric instruments are used as paper thickness gages and for quality control. Radioisotope devices for measuring the density and moisture content of soils are widely used in agricultural studies and for controlling fully automated irrigation systems. (L.C.L.)

51698 (A/CONF.49/P–487) ISOTOPE POWERED THERMOELECTRIC GENERATORS. Myatt, J.; Penn, A. W.; Poole, M. J. (Atomic Energy Research Establishment, Harwell (England)). May 1971. 11p. (CONF-710901–152). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The research carried out at the Atomic Energy Research Establishment since 1962 on isotope powered thermoelectric generators is reviewed. The generators are of two main types, ^{238}Pu fueled and ^{90}Sr fueled, which cover the range from fractions of a milliwatt to a hundred watts. The underlying materials research into the properties of heavily doped semiconductors, in particular bismuth telluride and germanium silicon alloys, and into junction materials is described. These materials, allied to experimentally determined design constraints which are presented, enabled the development of a range of thermopiles, whose properties are described and which deliver between 500 uW(e) and 10 W(e) at temperatures between 0 and 600°C. The properties of microporous silicate insulators, which have a thermal conductivity at room temperature lower than that of still air, are given. The design, construction, experimental testing and performance of a range of strontium-90 titanate-powered terrestrial generators are described. The design options; configuration, biological shield, heat-to-electric and voltage conversion are discussed as well as factors such as radiation damage which affect reliability. The installation and results from five field trials of generators allied to marine lights and navigation beacons are described. The general principles involved in the design and construction of miniature ^{238}Pu-fueled 500 μW(e) generators are presented. (auth)

51699 (A/CONF.49/P–493) CENTRIFUGE PLANTS IN EUROPE. Avery, D. G. (British Nuclear Fuels Ltd., Risley (England)); Bogaardt, M. (Ultra-Centrifuge Nederland N.V., The Hague); Jelinek-Fink, P. (Uran-Isotopentrennungs-G.m.b.H., Juelich (West Germany)); Parry, J. V. L. (British Nuclear Fuels Ltd., Risley (England)). May 1971. 9p. (CONF-710901–154). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The history of the development of the centrifuge in Western Germany, the Netherlands, and the United Kingdom leading up to the agreement for collaboration between the three Governments in 1970 is briefly reviewed. The initial plants now under construction, which will be owned and operated by the tripartite Enrichment Organisation, are described. The potential market for this organisation is reviewed and possible strategies for future expansion are discussed in the light of the technical and economic factors that will govern the commercial exploitation of the centrifuge as a uranium enrichment process. (auth)

51700 (A/CONF.49/P–605) FRENCH KNOW-HOW IN THE SEPARATION OF ISOTOPES. Leduc, C. (Commissariat a l'Energie Atomique, Paris (France)); Plurien, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Volvey, J. (Commissariat a l'Energie Atomique, Pierrelatte (France)); Bernaud, Cl. (USSI, Le Plessis-Robinson (France)). Jun 1971. 18p. (CONF-710901–404). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

French achievements in the sphere of isotope separation cover a variety of aspects. A wealth of knowledge has been built up, both via the design studies prior to building the Pierrelatte gas diffusion plant and in the actual operation of the plant, and via further research carried out since on this tried and tested process and others likely to succeed it. The first laboratory-scale data were obtained as early as 1954, while an industrial-scale experimental program led to prototype plant equipment in 1961 and was then pursued from 1964, when the "low" plant was commissioned, until the spring of 1967, when the plant was working at design capacity. Since then, the excellent operational performance of the plant has afforded a substantial contribution to the total fund of knowledge. Additionally, active research carried out into new types of equipment for a multinational-scale gas diffusion plant is now furnishing a solid basis for what, not long ago, was mere hypothesis. Other enrichment routes, particularly ultracentrifuging, are also being investigated. Over a period of more than fifteen years considerable experience has been gained in a variety of fields, which is to a large extent applicable to the various enrichment processes using UF_6, e.g., relating to: UF_6, fluorine, and its compounds, handling these substances at low or high pressures and in the gaseous or liquid states; technology of materials, circuits and seals—corrosion, tightness, surface treatment, passivation, and vacuum aspects; widely varying sizes of equipment, particularly valves; purging of process gas—drawing off, introducing, storing and purifying the UF_6; isotopic and chemical analysis, both in the laboratory and on line; construction, assembly, and interchangeability of repeat units; and data compilation and processing and control of repeat units—extensive familiarity with control and adjustment of separation cascades. (auth)

51701 (A/CONF.49/P–606) FRENCH DEVELOPMENT PLANS REGARDING THE SEPARATION OF URANIUM ISOTOPES. Frejacques, C.; Leduc, C.; Pecqueur, M. (Commissariat a l'Energie Atomique, Paris (France)). Apr 1971. 8p. (In French). (CONF-710901–250). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

France has advanced experience of various uranium isotope separation processes based on the major research and development programme carried out in connection with and subsequent to the design and construction of the Pierrelatte plant. In the first instance, France is studying the prospects for the design and construction of a gas diffusion plant large enough to meet a major fraction of European requirements at the end of the decade. The studies are designed to make out a case for construction of such a plant. The case will be based on experimental results, particularly those obtained from the Scale-1 pilot plants built and operating on the Pierrelatte Experimental Site, and on a detailed commercial project comprising, inter alia, stage, ancillary equipment, and layout designs. This project will furnish accurate data on the cost of building and operating a plant of this kind. Additionally, various aspects concerned with the economics and commissioning of a plant of this kind will be considered: firstly, the question of power supplies and, in particular, optimization of the total Plant/Grid system; and, subsequently, the progressive commissioning of facilities in order to keep pace with demand in the most rational manner. Indications will be furnished on the economic outlook for such a project. Work in France is not, however, being limited to gas diffusion research—although this is felt to be the process best suited to the design and construction of a plant within the relevant time limits—and the ultracentrifuge method, in particular, is being explored in view of its possible long-term potential for improvement. Indications will be furnished on certain major aspects, e.g., how the cost of the machines varies with the size of production runs, general plant design, and the ratio of the total cost of the plant to that of the individual machines. Finally, the economic prospects of this process will be compared with those of the alternatives. In conclusion, the possible outlook for the next few years will be looked at in European and world terms.

51702 (A/CONF.49/P–607) HEAVY WATER-RESEARCH ON PRODUCTION PROCESSES: PLANTS BASED ON THE FRENCH PROCESS. Roth, E. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Traourouder, R.;

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Viratelle, J.; Lefrancois, B. Apr 1971. 11p. (In French). (CONF-710901-251). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

During the last seven years, the C.E.A. has studied the heavy water production processes based on chemical exchange: water–hydrogen sulfide and mainly hydrogen–ammonia. The water–hydrogen sulfide process, which had been previously investigated, was reexamined recently in view of much larger capacities. The basic elements are now known for designing 400 tons/year plants, which would be required if large heavy water reactors were built. The ammonia–hydrogen exchange process has been subjected to detailed investigations on laboratory and semi-industrial scales and to economic studies. Further research is under way concerning the hydrogen–amine exchange process, the feed material limitation tied to ammonia synthesis gas utilization, hydrogen–water exchange with an homogeneous catalysis, and chemical conversion of water into hydrogen. (auth)

51703 (A/CONF.49/P–637) FRENCH ^{238}Pu PRODUCTION AND APPLICATION PROGRAMME. Berger, R.; Boucher, R.; Derian, J. C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1971. 25p. (CONF-710901–409). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Work relative to the production and applications of ^{238}Pu in France is discussed. The ^{238}Pu required to cover CEA needs was prepared by irradiation of ^{237}Np in the production reactor CELESTIN and of ^{241}Am in the research reactor OSIRIS. The techniques of chemical separation, pure metallic ^{238}Pu preparation and sealed source manufacture were studied and developed at the Fontenay-aux-Roses Nuclear Research Centre. The main originality of these techniques lies in the use of trilaurylamine solvent extraction processes. The CEA has actively contributed to the development of ^{238}Pu applications by participating in the work of the ENEA on isotopic batteries. Government research, in collaboration with the ALCATEL Company and the Broussais Hospital, has resulted in a prototype relay heart stimulator. The working model of this stimulator is manufactured by the MEDTRONIC Company using the battery developed by ALCATEL and fueled by a CEA source. The first human implantations in the world were performed at the Broussais Hospital in April and May 1970. Other applications of ^{238}Pu can be foreseen. It appears, in particular, to be the ideal solution to the problem of supplying energy to a thermodynamic machine for an implantable and autonomous artificial heart. At the present stage of research it is important to estimate the uncertainties regarding the possibilities of developing and extending the artificial heart technique. With this in mind the CEA has undertaken the adaptation of a non-conventional method, the DELPHI procedure. The comparison and statistical grouping of opinions supplied by a body of some hundred experts enabled the probable orders of magnitude of the demand to be defined and the possible extension in France of the artificial heart technique to be established. A similar study has been undertaken on a European scale in collaboration with the Isotopic Battery Research Association. (auth)

51704 (A/CONF.49/P–699) RADIOISOTOPE NEUTRALIZATION OF ELECTROSTATICAL CHARGES IN INDUSTRIAL CONDITIONS. Pismannik, K. D.; Brezhneva, N. E.; Ivanov, S. S.; Daniliul, I. A.; (and others) (Ministry of Light Industry, USSR). Jun 1971. 27p. (CONF-710901–416). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Neutralization of electrostatic charges by means of ionizing radiation has found broad application in the USSR. Examples are given of application of the neutralizers in the textile, printing, and chemical industries. (D.H.M.)

51705 (A/CONF.49/P–701) METHOD OF ISOTOPE TRACERS AND ITS USE IN THE INDUSTRIAL PRODUCTION. Gruzin, P. L.; Babikova, J. F.; Nesmejanov, A. N.; Postnikov, V. I.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 27p. (CONF-710901–479). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The development of isotope tracer methods is discussed including the activation method, nuclear and spectrometric method, and emanation method. The use of isotope tracers in applied science and technology is considered as well as their use in industry. (D.H.M.)

51706 (A/CONF.49/P–727) USES OF ISOTOPES AND RADIATION IN THE APPLIED SCIENCES AND TECHNOLOGY IN SPAIN. (Junta de Energia Nuclear, Madrid (Spain)). Jun 1971. 20p. (In Spanish). (CONF-710901–499). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The uses of isotopes and radiation in the applied sciences and technology in Spain since 1964 are reviewed. The present industrial uses of conventional techniques like industrial gamma radiography, nucleonic equipment for thickness, density, moisture, and level determinations in Spain are covered. In the field of applied research the following uses have been developed: wear studies in internal combustion engines with radioactive piston rings, radioactive static eliminators, nucleonic fuel gages in spacecraft, coating thickness measurement by means of x-ray fluorescence techniques, large flow determinations of water discharges using the radioisotopic total count and dilution methods, single-well technique applied to the study of underground water, use of radiation for the production of wood-plastic composites and the applications of activation analysis in Spain. In the field of development research, many nuclear techniques have been applied in industrial plants, i.e., the use of isotopic flow determination methods in hydroelectric power stations, the use of labeled sand to study the movement of sediments in beaches, the study of dam seepage with the use of radioactive tracers, and the determination of the mercury inventory in electrolytic cells. (auth)

51707 (A/CONF.49/P–728) USES OF ISOTOPES AND RADIATION IN AGRICULTURE AND FOOD SCIENCES IN SPAIN. (Junta de Energia Nuclear, Madrid (Spain). Instituto Nacional de Investigaciones Agronomicas, Madrid (Spain). Centro de Edafologia y Biologia Aplicada del Segura, Murcia (Spain)). Jun 1971. 24p. (In Spanish). (CONF-710901–500). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A general survey of the main uses of isotopes and radiation in agriculture and food sciences in Spain since 1964 is presented. These applications include uses of radioisotopes in studies of vegetal fertilization, herbicides, and pesticides, and food preservation by irradiation. Experiences with the radiopreservation of foods such as fruit juices, fish, potatoes, etc. are discussed. (L.C.L.)

51708 (A/CONF.49/P–768) ROLE OF NUCLEAR TECHNIQUES IN AGRICULTURAL RESEARCH IN DEVELOPING COUNTRIES. Swaminathan, M. S. (Indian Agricultural Research Inst., New Delhi). Aug 1971. 48p. (CONF-710901–511). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Some of the major goals of agricultural research in developing countries are: increasing the income and production potential of small holdings of about 2 hectares in size; improving the stability of production through new techniques of dry land farming, so as to avoid violent fluctuations in food grain availability in seasons when weather conditions are aberrant; increasing the employment potential of agriculture through the introduction of multiple and relay cropping systems; overcoming protein calorie malnutrition and under-nutrition through the development of high-yielding plus high-quality strains of cereals, oilseeds, vegetables and fodder and feed crops; increasing the efficiency of farming as reflected by the return a farmer gets from his investment on inputs like seeds, water, fertilizer, and pesticides; improvement of the productivity and quality of crops which have an export potential, so as to help in enlarging the foreign exchange earnings and bilateral and multilateral trade; and avoiding post-harvest spoilage of food and undesirable contamination and pollution. The use of radioisotopes and radiations as analytical tools, mutagens and sterilizing agents has opened up possibilities of accelerating the pace of progress in several areas of agricultural research. Some recent research using nuclear techniques carried out in developing countries which relate to soil and plant nutrition, tillage and moisture preservation, pest control, plant breeding, development of new cropping systems, protein improvement and food preservation is reviewed and discussed. (auth)

51709 (A/CONF.49/P–797) EIGHT-YEAR ACTIVITIES OF THE MIDDLE EASTERN REGIONAL RADIOISOTOPE CENTRE FOR THE ARAB COUNTRIES. Hazzaa, I. B. (Middle Eastern Regional Radioisotope Centre for the Arab Countries, Cairo (Egypt)). Jun 1971. 15p. (CONF-710901–428). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Center, which was established at the beginning of 1963 in accordance with an agreement between the International Atomic

Energy Agency, the United Arab Republic, and the other Arab countries, has functioned fulfilling its aims concerning training in radioisotope applications, carrying out research and promoting in general the development of the applications of radioisotopes. (auth)

51710 (A/CONF.49/P–831) PROGRESS IN THE APPLICATION OF RADIOISOTOPES TO STUDYING THE IMPROVEMENT OF PRODUCTION TECHNOLOGY IN THE POLISH INDUSTRY. Radwan, M.; Rzymkowski, T. (Institute of Nuclear Research, Swierk (Poland)). May 1971. 19p. (CONF-710901–434). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Some recent advances in research in the field of radioisotope application in Polish industry are presented. In the last year's research, works were concerned mainly with β scattering measurements, x-ray fluorescence techniques, and some new applications of neutron sources. (D.H.M.)

51711 (CONF-710428) CONFERENCE ON INNOVATIVE APPLICATIONS OF RADIATION, DALLAS, TEXAS, APRIL 22–23, 1971. (Southern Interstate Nuclear Board, Atlanta, Ga. Texas Radiation Advisory Board. Atomic Energy Commission, Washington, D. C.). 86p. Dep. NTIS.

Separate abstracts were prepared for four of the papers presented. Excerpts of an address by Representative Craig Hosmer and a paper on modern instrumentation in nuclear medicine are also presented. (D.H.M.)

For abstracts of individual papers see: 51361, 51660, 51712, and 51968.

51712 (CONF-710428–, Paper 3) RADIOISOTOPE INSTRUMENTS IN POLLUTION MEASUREMENT AND CONTROL. Badgett, Charles O. (Industrial Nucleonics Corp., Columbus, Ohio. Process Industries Div.). 12p.

From Conference on innovative applications of radiation; Dallas, Tex. (22 Apr 1971).

In Conference on innovative applications of radiation.

The application of radioisotopes to meet the challenges of the present day pollution concern is discussed. The areas of application included are: analysis of the material pollutant, material usage control for efficiency and economic operation, policing or monitoring the emission of the pollutant from the user plant, and a check of the pollutant in the environment. (D.H.M.)

51713 (ICRU–18) SPECIFICATION OF HIGH ACTIVITY GAMMA-RAY SOURCES. (International Commission on Radiation Units and Measurements, Washington, D. C.). 15 Oct 1970. 33p. ICRU, Washington, D. C. $2.50.

Specifications related to the quantity of radioactive material used and the radiation emitted are presented for sealed gamma sources. The sources are those primarily used in teletherapy and industrial radiography. Information is included on methods of specifying gamma sources, basis for source specification, teletherapy sources, and industrial radiation sources. (J.R.D.)

51714 (K-Trans–61-1) ISOTOPE SEPARATION IN THE CENTRIFUGAL FIELD OF A GAS ULTRACENTRIFUGE. Eckert, M. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from pp 71-9 of Stroemungsmechanische Vorgaenge in Graszentrifugen, DFVLR-Kolloquium, om 14 Mai 1970, Porz, Wahn, Germany. 9p. (CONF-700557–6). Dep. NTIS.

Results of research on separation of diffusion processes from flow processes and thermal conduction processes in gas ultracentrifuges are discussed. Work on development of homogeneous differential equations for use in boundary value problems associated with various feed configurations is also summarized. Theoretical discussions are included on the Cohen centrifuge equation and preassignment of boundary values. (J.R.D.)

51715 (K-Trans–61-2) SOLUTIONS OF THE NAVIER–STOKES EQUATIONS FOR FLOW IN COUNTERCURRENT GAS CENTRIFUGES. Lotz, M. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from pp 81-91 of Stroemungsmechanische Vorgaenge in Graszentrifugen, DFVLR-Kolloquium, om 14 Mai 1970, Porz, Wahn, Germany. 9p. (CONF-700557–10). Dep. NTIS.

Flow rates in UF_6 centrifuges are small compared with centrifuge peripheral speeds. These conditions are such that the Navier–Stokes equation, the energy equation, and the continuity equation can be linearized. A solution to this system of equations is derived which represents an axial countercurrent which is independent of the axial coordinate. The pressure and temperature are represented as having a linear course in axial direction. The temperature is constant across the radius. The solution is compared with solutions obtained by other workers. (J.R.D.)

51716 (K-Trans-61-4) STATUS OF THE FLOW THEORY TASKS IN THE PROJECT "URANIUM ENRICHMENT WITH GAS CENTRIFUGES." Langbein, G. Translated for Oak Ridge Gaseous Diffusion Plant, Tenn., from pp 15-24 of Stroemungsmechanische Vorgaenge in Graszentrifugen, DFVLR-Kolloquium, om 14 Mai 1970, Porz, Wahn, Germany. 10p. (CONF-700557-9). Dep. NTIS.

Discussions are summarized in which personnel engaged in research gas centrifuge flows are listed. Information is also included on goals of various centrifuge research organizations, and on the work at URANIT. (J.R.D.)

51717 (MDC G–3124) PLUTONIA/CURIA COMPATIBILITY TESTING. Quarterly Report No. 11, April–June 1971. Andelin, R. L.; Watrous, J. D. (McDonnell Douglas Astronautics Co., Richland, Wash. Donald W. Douglas Labs.). Jul 1971. Contract AT(45-1)-2138. 41p. Dep. NTIS.

Attack mechanisms by plutonia-molybdenum cermets on refractory alloy double containers appear to be explainable on the basis of results of prior plutonia/monometallic refractory alloy tests. Specimens have been examined after 1500°C 500-hour, 1800°C 1000-hour, and 2000°C 1000-hour exposures. Further exposure is underway at 1500 and 1800°C on both PMC and SSC. Evidence of significant deterioration in the Battelle-Columbus Laboratories plutonia-molybdenum cermet has been shown for specimens exposed at 1800 and 2000°C for 5000 and 10,000 hours. Curia-244 appears to attack tungsten intergranularly, molybdenum by solution, and W-25Re, Re, Mo-46Re, and W–30Mo–30Re by minor precipitation/void formation after exposure at 2000°C for 1000 hours. Exposure continues at 1800 and 2000°C. A set of 10 specimens was assembled and exposure started at 1500°C to evaluate various barriers between plutonia and noble metals. (auth)

51718 (MLM–1816) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION: JANUARY–MARCH 1971. (Mound Lab., Miamisburg, Ohio). 28 Jul 1971. Contract AT(33-1)-Gen-53. 44p. Dep. NTIS.

Results are reported on studies of stable gaseous isotope separation and purification, including: carbon isotope separation by distillation, chemical exchange, thermal diffusion, and conversion; separation of stable gaseous isotopes of He, Ne, Ar, Kr, and Xe; thermal diffusion research (molecular beam scattering and transport properties, including column determination of α_T and mutual diffusion coefficients); and low temperature research on thermal transpiration cascade technique, thermal transpiration surface studies, ^{3}He distillation, development of ^{3}He refrigerator, and superfluid film phase transition. (L.C.L.)

51719 (MLM–1831) EXAMINATION OF SNAP-27 HEAT SOURCE FCA4 AND PREPARATION OF FUEL FOR FCA8. Prosser, D. L. (Mound Lab., Miamisburg, Ohio). 23 Jul 1971. Contract AT-33-1-GEN-53. 51p. Dep. NTIS.

The capsule and fuel of SNAP-27 fuel capsule assembly (FCA)4 were examined for changes which may have occurred during its life of 2.25 yr. No significant effects were noted. The fuel was reprocessed and qualified for use in SNAP-27 FCA8. (auth)

51720 . (NUMEC–3292-20) AVAILABILITY AND COST OF ^{10}B FOR REACTOR CONTROL. Fersch, K. E.; Hoynacki, J. J.; Pepkowitz, L. P. (Nuclear Materials and Equipment Corp., Lewiston, N. Y. Niagara Div.). 18 Feb 1971. Contract AT(40-1)-3292. 31p. Dep. NTIS.

Within the last two years, plant modifications and additions have decreased the cost of highly enriched boron-10 by about 25%. An extensive study has been completed in which the production requirements necessary to produce boron-10 in the 30 to 60 wt. percent enrichment range at an economical cost for commercial nuclear reactors was determined. The study showed that the addition of two 1.5 meter diameter 55 foot high columns with Sulzer type CY packing, together with the present equipment, would be the optimum size plant to make the least expensive boron-10 from plant size and feed rate considerations. At product rates below about 12,000 kg/year of boron-10, there is a negligible cost difference between 30 and 60% product for the same amount of boron-10. Below 12,000 kg/year of boron-10 product, the resulting cascade waste stream becomes highly enriched in boron-11 (>98% boron-11 to total boron). There is a minimum cost for each of the product enrichments at a particular product rate but that the likely demand for boron-10 will result in slightly higher costs. (auth)

51721 (SC-DR–710101) PIONEER RTG SAFETY EVALUATION: PHASE I IMPACT AND LAUNCH ABORT SEQUENTIAL TESTS. Baker, F. L.; Cranfill, R. C. (Sandia Labs., Albuquerque, N. Mex.). May 1971. 89p. Dep. NTIS.

Phase I impact and the launch abort sequential tests were performed to investigate the Pioneer RTG heat source response to

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postreentry impacts and Atlas/Centaur/TE-364 launch abort environments. A description of each test and the results are presented. The test levels used in this test program were based on reference environments defined as the maximum levels expected from the various aborts. Thus, these levels are considered conservative. The response of the capsules to the environments imposed was generally good. However, two capsules in the impact tests and two capsules in the solid propellant direct contact fire test were breached. (auth)

51722 SHOCK REPRODUCTION ON SHAKERS. Otts, John V.; Hunter, Norman F. Jr. (Sandia Labs., Albuquerque, N. Mex.). pp 561.1-6 of Proceedings of the 24th Annual ISA Conference. Pittsburgh; Instrument Society of America (1969).

From twenty-fourth annual conference of Instrument Society of America; Houston, Tex. (27 Oct 1969). See CONF-691004-(Pt.2).

A test technique was recently developed and utilized whereby single or repetitive shock pulses are generated on electrodynamic and hydraulic shakers. The specified pulse can be generated at any reference point on the test item, test fixture or table top (test assembly). The test procedure basically consists of equalizing the transfer function between the signal source and the input control (reference) point. The generated pulses are limited to low amplitude and moderate duration due to the force, displacement and frequency response characteristics of vibration machines. The basic advantages of having this limited shock capability in the vibration laboratory include: repetitive shock pulse capability, accurate pulse generation and reproduction from test to test, common fixtures for vibration and shock tests, thus reducing design and fabrication expenses, and reduction in test setup time on units where both vibration and shock tests are specified. The following phases of shock testing on vibration machines are considered: typical shock pulses and their frequency-amplitude spectrums, test setup and procedure, limitations of electrodynamic and hydraulic vibration equipment (including performance curves), and test results on several SNAP 21 units which were subjected to a 6 g, 6 μsec sawtooth pulse. (auth)

51723 DETERMINATION OF ASYMPTOTIC DISTRIBUTION IN SEPARATION TUBES. II. Zieger, K. (Zentralinstitut fuer Isotopen- und Strahlentechnik, Leipzig). Isotopenpraxis; 7: No. 4, 145-7(Apr 1971). (In German).

The concentrations establishing themselves at the outlet of a stationary countercurrent column, provided for the separation of an isotopic multicomponent mixture, as a rule, approach certain limiting values with unlimited increase of column length. These limiting distribution values, or also referred to as asymptotic distribution values, can, under the most simple separation conditions, be determined by means of elementary mathematical methods. (auth)

51724 GAMMA-SPECTROMETRIC WEAR TEST PERFORMED ON SIMULTANEOUSLY WORKING PARTS. Keoemley, G. Isotopenpraxis; 7: No. 4, 126-32(Apr 1971). (In German).

A method is described for using gamma spectrometry for simultaneously measuring the wear of several machine parts in an operating Diesel engine. Labeling of the parts was effected by neutron activation in a reactor. (auth)

51725 ^{35}S USED TO EXPLORE THE SULPHUR BALANCE OF METALLURGICAL PROCESSES. Michalik, J.; Kominek, J.; Bazaniak, Z.; Radwan, M. (Institut fuer Kernforschung, Swierk, Poland). Isotopenpraxis; 7: No. 4, 132-8(Apr 1971). (In German).

The methods and results are described for the investigation of sulfur balance in blooming and open-hearth processes, based on the use of ^{35}S. Methods of labeling feed materials are presented. (auth)

51726 APPARATUS FOR GIVING MEDICAL TREATMENT BY IRRADIATION FROM RADIOACTIVE SUBSTANCES. Sauerwein, Kurt. British Patent 1,231,530. 12 May 1971. Priority date 5 Sep 1969, Germany.

A description is given of a radioapplicator for treating animals or human patients by local irradiation. Features ensuring precision, reliability and safety are emphasized. (F.M.M.)

51727 OVERVIEW OF AEC'S ISOTOPES DEVELOPMENT PROGRAM. Bizzell, Oscar M. (Atomic Energy Commission, Washington, D. C.). pp 5-12 of Transactions of the Isotopic Snow Gage Information Meeting. Boise, Idaho; Idaho Nuclear Energy Commission (1970).

From Isotopic snow gage information meeting; Sun Valley, Idaho (28 Oct 1970). See CONF-701053.

Some of the major program areas of the AEC's Isotopes Development Program, which is concerned with the production and uses of radioisotopes, are described. These applications include: uses of radioisotopes as radiation sources for neutron activation analysis, for tracer studies, and for process radiation, and uses of radioisotopes as power sources in implantable circulatory support systems and in thermoelectric generators for remote locations such as in space and undersea. (L.C.L.)

51728 THERAPEUTIC IRRADIATION APPARATUS. (to Barapio SA). British Patent 1,233,738. 26 May 1971. Priority date 18 Oct 1967, Switzerland.

A description is given of a therapeutic irradiation apparatus comprising a protective casing enclosing a support for a γ source, such as radium, two filters, and a neutron source. The chemical composition of the filters is given and the mode of operation of the apparatus and safety devices is described. (F.M.M.)

51729 APPLIANCE FOR INTERSTITIAL RADIATION OF ORGANS IN THE BODY. Holmer, Bernt Arne Gustaf (to Aktiebolaget Atomenergi). British Patent 1,239,493. 14 Jul 1971. Priority date 2 May 1968, Sweden.

Specifications are given for an appliance with a cannular tube containing a radioactive compound to be used for interstitial irradiation of organs of the human body or of animals. Advantages of the appliance are outlined. (F.M.M.)

51730 SUCCESS OF THE ISOTOPE SEPARATION THEORY AND ITS USE IN NONISOTOPIC TECHNOLOGY. Rozen, A. M. Isotopenpraxis; 6: 463-70(Dec 1970). (In Russian).

The use of isotope separation theory in non-isotopic technology is reviewed. The study of exchange properties of certain hydrides as a function of the atomic number of the hydrogen partner is contrasted with the extraction behavior of various chlorides by TBP. Column processes are compared, such as distillation, chemical exchange, thermodiffusion, and mass diffusion, as applied to isotopic and non-isotopic processes. The "point-of-intersection" method for obtaining a convenient formula for calculation of the number of necessary stages in a separation column is discussed, both from the point of view of isotope enrichment technology, and from the need for any desired mass exchange processes characterized by a constant coefficient of separation. It is shown that the same equation of separation dynamics for isotopes is also applicable to the dynamics of mass-exchange such as liquid-gas, liquid-liquid, etc. For optimization of cascade separation of isotopes the theory has been well developed, and now has been put to use in the separation of substances having similar properties such as the rare earth elements, several non-ferrous metals, etc. (K.S.W.)

51731 STUDY OF MINE DETECTION BY MEANS OF NEUTRON-INDUCED GAMMA RAYS. Mynatt, F. R.; Alsmiller, R. G. Jr.; Williams, L. R. (Oak Ridge National Lab., Tenn.). Nucl. Technol.; 12: No. 3, 329-35(Nov 1971).

Calculations were carried out to determine the feasibility of locating land mines by detecting the photons induced in the mine by the neutrons from a fission source. It was concluded that the fission source strength required to achieve an appreciable counting rate is sufficiently large that mine detection by the proposed method is problematical. (auth)

Materials Testing

Refer also to abstracts 51684, 51724, 51770, 51783, 51796, 51807, 51809—51818, 51820, 51822, 51831—51841, 51864, 51964, 52329, 52335, 52349, 52350, 52442, 52493, 54123, 54225, and 54292.

51732 (RCN-135) APPARATUS FOR NEUTRON RADIOGRAPHY. de Munk, P. J.; Leeflang, H. P. (Reactor Centrum Nederland, Petten). Mar 1971. 64p. Dep. NTIS (U. S. Sales Only).

A description is given of an apparatus for neutron radiography that was designed primarily for nondestructive investigation of capsules irradiated in the HFR. To realize this purpose and to facilitate the design, the apparatus is to be positioned in the HFR reactor pool and makes use of the so-called divergent collimator. In this way, there is no need for complex shielding provisions and also the collimated beam is obtained in a very inexpensive way. Because a high flux position is available neutron radiographs can be produced in very short time while image sharpness is maintained. The main components are considered and a short survey of the design tests that were performed presented. Strength calculations and several important physical aspects that influenced the design are given. A short survey of the complete radiographic procedure and some requirements for capsules to be radiographed are described. (auth)

51733 (SGAE-IB/IA-24/1971) RADIOMETRIC MEASUREMENTS IN MAGNESITE. Frevert, E.; Roetzer, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). [nd]. 16p. (In German). Dep. NTIS (U. S. Sales Only).

Tar impregnation and quality of magnesite bricks were determined by radiometric methods. The bricks serve as cladding material for vessels containing liquid steel. Tar impregnation was determined with neutrons from an Am–Be source, which were counted with a lithium semiconductor detector. Quality of the bricks was tested with a ^{137}Cs source. Equipment and results are compiled in figures and tables. (H.B.G.)

51734 (Y-DL-140) QUANTITATIVE INTERPRETATION OF RADIATION OPACITY CHANGES BY RADIOGRAPHY. Mundt, F. D. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 8 Oct 1970. Contract W-7405-eng-26. 24p. (CONF-710319-1). Dep. NTIS.

From Conference of the American society of nondestructive testing; Los Angeles, Calif. (8 Mar 1971).

A study was conducted to evaluate a method of quantitatively interpreting radiation opacity changes in conventional radiographs. The interpretive technique employs the superposition of the film with the defect indication and a film with a standard penetrameter on a nominal thickness of material. Two problems associated with this method were examined experimentally and theoretically: the mode of addition of superimposed film density, and the dependence of film density on material thickness for constant radiographic parameters. Both of these relationships are reported for Type 304L stainless steel, and the actual magnitude of several low-opacity values is calculated and verified experimentally. It is found that simple straightforward judgments for high-opacity defects can be made; but, due to the nonlinearity of the radiographic system, significant allowances must be made in judging low-opacity defects. An expression is derived for calculating the actual low-opacity defect magnitude as a function of the apparent defect magnitude, and the relationship is shown to be independent of all radiographic parameters. Experimental measurements are made to verify this relationship, and a curve is developed to portray it. Since this curve is unaffected by changes in the radiographic parameters, it may be used for many different radiographic situations and materials. This technique is essentially one of interpretation and therefore requires no special equipment other than special penetrameters. (auth)

51735 STATISTICAL ASSESSMENT OF STRENGTH REDUCTION BY WELDING DEFECTS DETERMINED BY RADIOGRAPHY. Denes, N. Materialpruefung; 13: No. 3, 89-91 (1971). (In German).

The quality evaluation of welding seams is made by comparison of x-ray test results with results of tensile tests. In this way information can be obtained on strength and ductility reduction of a welded seam. The relation between strength and evaluated defect is not rigidly deterministic but stochastic. An evaluation is, therefore, only possible by statistical analysis of a large number of test results. The influence of raw material and of different electrodes in case of pore and center defects is investigated for the assessment of seam strength of sheet plates. (INIS)

51736 NEUTRON RADIOGRAPHY USING A SMALL SUBCRITICAL REACTOR. Bouchey, G. D.; Gage, S. J. (Univ. of Texas, Austin). Int. J. Nondestruc. Test.; 2: No. 4, 335-53 (Mar 1971).

It was demonstrated experimentally that neutron radiography is feasible with a small subcritical nuclear reactor. At present market prices for U and radioisotopes, the subcritical assembly is no more economical than radioisotope in an assembly of pure moderator material; however, the intensity of the neutron beam extracted from the reactor is significantly greater. The enhancement of neutron flux increases the size and quality of the radiography beam, and it is possible that this might be the only source applicable to neutron radiography of objects with a large cross section. (B.L.M.)

51737 FLEXIBLE NEUTRON RADIOGRAPHY FACILITY USING A TRIGA REACTOR SOURCE. Whittemore, W. L.; Larsen, J. E.; Shoptaugh, J. R. (Gulf General Atomic Co., San Diego, Calif.). Mater. Eval.; 29: 93-8(May 1971).

A complete neutron radiography facility was designed and constructed. A description is given of the goals for the design and the approaches employed in meeting these goals. A small neutron and gamma-ray background at the detector as well as for personnel was one important goal. Another goal was to define accurately the effective neutron source. A specially shaped region at the source end of the collimator clearly defines the effective size of the source without sacrificing a major component of the neutron current from the source. This major component (approximately 45% of total neutron current) comes from the cylindrical wall of the port near the source but does not contribute to deterioration of the neutron radiograph. A special technique was devised for diagnosing the details of the neutron source. The effort to construct this commercial neutron radiography facility has been successful, both with regard to the high quality of the neutron radiographs and the small resulting dose rates for the facility personnel. (auth)

51738 ROOF-BOLT TEST AND APPLICATION IN SUPPORTING A TWO-FOOT-THICK ROOF BED. Bradshaw, R. L.; McClain, W. C. (Oak Ridge National Lab., Tenn.). pp 466-70 of Third Symposium on Salt. Vol. 2. /Rau, Jon L. (ed.). Cleveland; Northern Ohio Geological Society, Inc. (1970).

From third international symposium on salt; Cleveland, Ohio (22 Apr 1969). See CONF-690456-(Vol.2).

In Project Salt Vault there was a 2-ft-thick bed of salt in the roof which was separated from the salt above by a shale parting. This bed was sagging at a rate of about 0.2 in./yr in the center of a 60- × 44-ft room. This was normal and would have been of no concern except that it was planned to place heat sources in the floor. Experience indicated that this might cause an order of magnitude increase in the sag rate, and could possibly cause a roof fall. There was little available information concerning anchorage capacities which could be developed in rock salt. Therefore, a test was made with 37 bolts installed on 4-ft centers in staggered rows in the center of the room. Using a special retorquing procedure, an average load of about 8000 lb/bolt was achieved, the roof was lifted about 0.08 in., and the sag rate was reduced to zero. On the basis of this test, the experimental area was bolted using about 1600 bolts. When the heat was applied in the floor, the anticipated horizontal thrust on the roof bed (which would have resulted in accelerated sag) took place, and the bolts reached loads of 15 to 20 thousand pounds (four to five times the dead-weight load), but the bed was prevented from any further sag. That the anchors were capable of developing this amount of strength in salt is postulated to be a result of the retorquing procedure used. (auth)

51739 ASPECTS OF IN-SERVICE INSPECTIONS ON REACTOR PRESSURE VESSELS IN GERMANY. Meyer, H.-J. (Maschinenfabrik Augsburg-Nurnberg AG, Nuremburg). Mater. Eval.; 29: No. 8, 171-81(Aug 1971).

In view of the safety requirements for nuclear reactor pressure vessels, nondestructive inspections are to be carried out not only during manufacture but also during the whole operational life of a reactor. Ultrasonic inspection systems and manipulation equipment are described which permit economical inspection of reactor components, at the same time avoiding subjective evaluation and manual probe guidance. The inspection system and manipulation are arranged so that when modern electronic components are employed two-dimensional flaws in particular (e.g., cracks) can be traced with a high degree of dependability. (auth)

51740 NEUTRON RADIOGRAPHY OF APOLLO ORDNANCE. Golliher, K. G.; Hanna, L. E. (North American Rockwell Corp., Los Angeles). Mater. Eval.; 29: No. 8, 165-70(Aug 1971).

Neutron radiography is being used on a production basis to examine the internal details of ordnance employed in the Apollo Program. Ordnance objects range from charges which separate the massive booster stages to those which trigger the release of reentry parachutes. Neutron radiography is similar to radiography, but has among its unique capabilities the ability to distinguish and determine hydrogen-bearing material within metallic structures. It is this feature that makes neutron radiography a necessary inspection tool for the nondestructive testing of Apollo ordnance. (auth)

51741 ^{60}Co RADIOGRAPHY. PART I. USE OF COPPER SCREENS AND LEAD FILTERS FOR RADIOGRAPHY OF STEEL. Splettstosser, H. R. (Eastman Kodak Co., Rochester, N. Y.). Mater. Eval.; 29: No. 8, 189-92(Aug 1971).

When radiographing steel with ^{60}Co, one can obtain better penetrameter sensitivity by using copper screens instead of lead screens. For a given film, the exposure must be increased by about a factor of 2 when copper screens are used; however, the improvement in radiographic sensitivity is greater than that obtained when lead screens are used with a slower film which requires a factor of 2 increase in exposure. The difference in radiographic sensitivity is caused by a difference in the recording of scattered radiation. The relationship between radiographic image quality, scatter buildup factor and exposure was determined for the cases where the scatter buildup factor is changed by filtration and/or by use of copper screens. For a given film, image quality improves, within limits, with the increase in exposure necessitated by the decreased recording of scattered radiation. (auth)

51742 FIELD EVALUATION OF HEAVY-WALLED PRESSURE VESSELS USING ACOUSTIC EMISSION ANALYSIS. Waite, E. V.; Parry, D. L. (Idaho Nuclear Corp., Idaho Falls). Mater. Eval.; 29: No. 6, 117-24(Jun 1971).

A portable acoustic analysis system has been developed which is used to detect, locate, and analyze microacoustic energy emissions

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originating from flaws or cracks within a stressed structure. The system was developed for potential use as a nondestructive test technique for the safety assessment of pressure retention envelopes of nuclear power reactors. To aid in the development and evaluation of the acoustic system, acoustic emission data were obtained and on-site analyses made of the integrity of several large industrial chemical reactor pressure vessels in conjunction with the hydrostatic acceptance testing of the vessels. The system was shown to be capable of detecting and locating acoustic emission sites (flaws) as small as 0.1 in. in size with acoustic signal transmission distance of up to 60 ft from the emission site to the detector. (auth)

51743 NEUTRON RADIOGRAPHY WITH A SEALED-TUBE NEUTRON GENERATOR AND GRAPHITE MODERATOR SYSTEM. Vasilik, Dennis G.; Murri, Richard L. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Mater. Eval.; 29: No. 6, 130-2(Jun 1971).

Neutron radiographs of good quality have been produced using a sealed-tube neutron generator and a graphite moderator system. The graphite moderator is a right cylinder 30 in. in diameter and 30 in. high. A thermal neutron flux at the object of 1.1×10^5 n/cm^2-sec and a cadmium ratio of 3.5 has been measured. The L/D ratio was 7, the x-ray contribution was 0.50 mr/sec and the resolution was measured to be 0.01 in. (auth)

Protective Structures

Refer also to abstract 52494.

Radioactive Material Handling

Refer also to abstracts 51386, 51406, 51626, 51651, 51738, 51869, 51938, 52060, 52099, 52102, 53458, 53988, 54212, 54217, and 54307.

51744 (A/CONF.49/P-204) CONTROL OF SOURCES AND SPECIAL NUCLEAR MATERIAL IN BRAZIL. Santos, Lydia dos (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro); Abrao, Alcidio (Instituto de Energia Atomica, Sao Paulo (Brazil)). Jun 1971. 15p. (CONF-710901-370). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The steps presently being taken for control of special nuclear materials in Brazil are described. The controls required by the International Atomic Energy Agency (IAEA), through the trilateral agreement among Brazil, the United States, and the IAEA are considered. The relationship between the National Nuclear Energy Commission and the Institutes and private organizations is described. The criteria are considered that will be applied in the development of this control system as a method of safeguards, with special attention being paid to its effectiveness since it is also needed as a means of correct administration of these materials by the National Nuclear Energy Commission. (auth)

51745 (A/CONF.49/P-253) MANAGEMENT OF RADIOACTIVE EFFLUENTS FROM NUCLEAR POWER STATION CURRENTLY UNDER OPERATION IN JAPAN AND ENVIRONMENTAL MONITORING. Toyota, Masatoshi (Tokyo Electric Power Co., Inc. (Japan)); Hamaguchi, Shun-ichi (Kansai Electric Power Co., Inc., Osaka (Japan)); Asada, Chuichi (Japan Atomic Power Co., Tokyo). May 1971. 10p. (CONF-710901-96). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Methods for managing gaseous and liquid radioactive wastes from four nuclear power plants currently in operation in Japan are described. Environmental radiation monitoring activities in the areas surrounding the plants are discussed. Tabulated data on the monthly releases of radioactive effluents from the power plants are presented. (L.C.L.)

51746 (A/CONF.49/P-265) REVIEW OF RESEARCH AND DEVELOPMENT IN JAPAN ON SAFEGUARDS FOR NUCLEAR MATERIALS IN FABRICATION PLANTS. Matsubara, Takeo (Sumitomo Electric Industries, Ltd., Osaka (Japan)); Seki, Yoshinobu (Mitsubish Atomic Power Industries, Inc., Tokyo, Japan); Yamamoto, Tatsuro (Furukawa Electric Co., Ltd., Tokyo, Japan). May 1971. 16p. (CONF-710901-100). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The development of reliable nuclear materials accounting systems for safeguarding nuclear materials in Japanese fuel fabrication facilities is discussed. The following are described: a computerized materials accounting and control system for plants manufacturing highly-enriched Al–U alloy plate-type fuels; computer programs for materials accounting in low-enriched UO_2 fuel plants; and an automatic weighing and recording system for verifying the quantity of UO_2 present in a plant for fabricating UO_2 pellets. It is concluded that Japanese plant operators are making progress in developing effective safeguards systems and inspection procedures which do not interfere with normal fuel plant operations. (L.C.L.)

51747 (A/CONF.49/P-286) ASPECTS OF THE CONTROL OF REPRESENTATIVE INDUSTRIAL INSTALLATIONS. Beets, Ch.; Goens, J. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)); Dragnev, T. (International Atomic Energy Agency, Vienna (Austria)); Goossens, H.; (and others) (Metallurgie et Mecanique Nucleaires S.A., Dessel (Belgium)). Jul 1971. 25p. (CONF-710901-372). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The cases chosen for study are: that section of the (90%) enriched uranium fuel cycle which is located on Belgian soil, with an annual output of 50 kg_{eff}, and which connects the following three installations: the MMN fabrication plant, the BR2 test reactor, and the Eurochemic reprocessing plant; the uranium fuel fabrication line for LWR's installed at the MMN plant, with an output of 250 kg_{eff}; and the industrial sized plutonium fuel fabrication plant of Belgonucleaire presently under construction. The same general principles were applied to these cases to deduce the characteristic parameters: W, inventory in kg_{eff} and τ, transit time of the material through the plant. The choice of strategic points and of measuring methods was made with a view to improving the cost/efficiency ratio. Non-destructive tests are nevertheless necessary as most cases concern the measurement of finished products and it is this type of control that is considered. (auth)

51748 (A/CONF.49/P-415) OPTIMISED MATERIAL ACCOUNTING SYSTEM FOR SAFEGUARDS IN A NUCLEAR FUEL CYCLE. Avenhaus, R.; Drosselmeyer, E.; Gupta, D.; Hagen, A.; Kraemer, R.; Nentwich, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Apr 1971. 23p. (CONF-710901-145). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The influence of some cycle-inherent parameters on the optimization of a material accountancy system for safeguards purposes was investigated. It was shown that the use of containment measures (identification and sealing) instead of duplicating material balance measures at a number of points in the fuel cycle may cause a significant reduction in the efforts. Further reduction can be obtained by using isotopic correlations in the system and making the information system transparent at the facilities. Although use of historical data on material unaccounted for (MUF) and measurement accuracy may also cause a further reduction in the efforts, collection of data on an international level is required before their use can be quantified. (auth)

51749 (A/CONF.49/P-426) SCIENTIFIC BASING AND PRACTICE OF LIQUID RADIOACTIVE WASTES DISPOSAL IN DEEP GEOLOGICAL STRATA. Spitsyn, V. I.; Pimenov, M. K.; Yudin, F. P.; Balukova, V. D. (State Atomic Energy Committee, USSR). Jun 1971. 33p. (CONF-710901-376). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The theory of radioactive waste disposal in ground is discussed; the main methods of waste disposal into deep formations and their applications are considered. Special attention was given to waste disposal in water-bearing beds/collectors. The basic sanitary-radiation safety requirements for the liquid waste repositories were determined. The steps of the geological-hydrological investigations for liquid waste disposal in the ground are given. They are the generalization of data on region geologic structure, region reconnaissance by hole drilling and carrying out complex geophysical studies, and the detailed investigation of strata collectors and waterproof strata. The possibility of using water-bearing beds and a single stratum collector for wastes burial is estimated. The results of a physical-chemical investigation are presented. The conditions of compatibility of liquid radioactive wastes with ground and stratum water as well as the required waste treatment for burial in given geological conditions were determined. Different types of wastes burials, the designated layout of burial holes, as well as methods of stratum recovery are considered. The effects of liquid wastes macrocomponents and the activation level on the choice of the burial system were determined.

The stages of preliminary waste treatment and the system for controlling the waste storage are described. The investigations which were carried out and the experience of burying low- and intermediate-activity saline wastes under the geological conditions considered confirm that the underground burial method ensures radiation safety at a reasonable cost. (auth)

51750 (A/CONF.49/P–512) U. K. EXPERIENCE OF RADIOACTIVE WASTE RELEASE TO THE ENVIRONMENT AND EXPECTED WASTE MANAGEMENT IN FUEL CYCLES IN THE 1980s. Preston, A.; Mitchell, N. T. (Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Fisheries Radiobiological Lab.); Birse, E. A. (Scottish Development Dept., Edinburgh); Dunster, H. J.; (and others) (National Radiological Protection Board, Harwell, Eng.). May 1971. 12p. (CONF-710901–229). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The United Kingdom experience of the release of radioactive wastes to the environment is reviewed. It is concluded that the assessment method using critical pathways and critical population groups provides a sound scientific basis for the control of radioactive wastes from major installations in conformity with the recommendations of the ICRP. This scientific control has been supplemented by a statutory procedure for these major discharges that ensures that they are further limited to as low a figure as can reasonably be achieved. Careful administrative control is also maintained of the increasing number of small users of radioactive materials. The experience has shown that nuclear power generation, as practiced in the UK, gives rise to no significant waste disposal problems but does show that more attention needs to be paid to the wastes from the reprocessing of nuclear fuel. The future development of waste disposal practices for the fuel cycles expected in the next decade or two is reviewed. The likely changes in the quantity and quality of wastes from fuel fabrication and reprocessing and also from the associated research programs are assessed on the basis of the projected nuclear power program. It is concluded that detailed development of current methods will be sufficient to deal with almost all these wastes. It is foreseen that only in two areas will there be a need for substantial changes in waste management. First, glassification of the main fission product wastes from fuel reprocessing, now technically feasible, may become the preferred method of storage within 10 or 20 years. Second, solid wastes containing more than traces of Pu may require recovery of the Pu to levels not normally regarded as economic, in a country having no suitable area of geological isolation for their ultimate disposal. (auth)

51751 (A/CONF.49/P–558) EXPERIENCE WITH NATIONAL SYSTEM OF ACCOUNTING FOR AND CONTROL OF NUCLEAR MATERIAL IN CZECHOSLOVAK SOCIALIST REPUBLIC. Beranek, J.; Zoch, O. (Czechoslovak Atomic Energy Commission); Krivanek, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Jun 1971. 23p. (CONF-710901–476). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The national accountability and control system of nuclear material as applied to different types of nuclear facilities in Czechoslovakia is described. The experience gained in the establishment of initial selection of individual material balance areas is discussed, and the reporting system and compilation and verification activities of the Nuclear Safety and Safeguards Department of Czech AEC are described. Analytical methods and equipment used for safeguards purposes are described. The expected development of national safeguards system to cover the future nuclear power program in Czechoslovakia is outlined. (auth)

51752 (A/CONF.49/P–611) FRENCH STUDIES ON THE TRANSPORT OF IRRADIATED FUELS FOR POWER REACTORS. Labrousse, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1971. 24p. (CONF-710901–407). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Research programs in France for studying the transport of spent fuels from power reactors are reviewed. The technical aspects of determining the type, size, and quantity of shipping casks required are discussed. The economic problems which control the choice of packaging type and mode of transport are emphasized. Thermal studies of heat dissipation from packaged fuels and safety studies of package integrity under fire and shock conditions are mentioned. It is concluded that the choice of packaging type and mode of transport is conditioned by and dependent on the choice of handling and storage facilities and by the reactor discharging strategy, and that the best packaging is not necessarily the one whose technical performance is highest, but the one which is cheapest to use for the reactor operator, the reprocessing plant, and the carrier. (L.C.L.)

51753 (A/CONF.49/P–617) EQUIPMENT FOR INTERVENTION IN A RADIOACTIVE ENVIRONMENT. Vertut, J.; Guilbaud, J. P.; Kissel, Ph. P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1971. 27p. (CONF-710901–456). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Many studies carried out so far on mobile machines equipped with manipulators for work under very strong irradiation conditions have produced a choice of telecommanded or piloted systems to carry out remote-control operations, either in case of accident or for the dismantling of high-activity equipment. The handling strategy which emerges from studies carried out in France and from relations now established on a European scale is reported. The range of machines necessary to cope with the different types of operations both inside and outside the plants will be reviewed. This range extends from heavy public works-type machines to the light vehicle carrying precision manipulators. The distance at which these machines are used demands a telecommand technology ranging from the multi-conductor cable connection to the Hertzian connection. The experience acquired with a vehicle-borne telemanipulation unit in operation for the last few years is described, including a second-generation machine capable of surmounting large obstacles and a third-generation machine suitable for all terrains, carrying two master-slave manipulators and able to receive a Hertzian connection. The magnitude of the means contemplated should lead to a pooling of equipment on an international scale. The last projects mentioned will be undertaken in technical collaboration with specialists from Federal Germany, the United States, and Great Britain. (auth)

51754 (A/CONF.49/P–725) SAFEGUARDS SYSTEM OF THE COMMISSION OF THE EUROPEAN COMMUNITIES. Jacchia, E.; Finzi, S. Jun 1971. 16p. (CONF-710901–323). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Treaty establishing the European Atomic Energy Community set up the first complete safeguards system to be put into practice by an independent authority within an organization comprising several states. An analysis of the main Treaty provisions governing the activity of the Commission's Directorate for Safeguards is followed by a detailed description of its structure. An outline is presented of the functions of the inspectorate, with the accent on the various procedures applied according to the case (routine inspections, special inspections, spot checks, etc.). The operation of the centralized accounting system, under which all the data communicated by persons subject to such controls are brought together at the Headquarters of the Commission, is described. Assessments are made of the overall work performed by the Commission's Directorate for Safeguards in order to ensure effective control over the use of nuclear materials for peaceful purposes only. Research aimed at optimizing the safeguards and controls system from the standpoint of efficiency, economic benefit and minimum intrusion is discussed. Initiated in 1969, this research concentrated on systems studies, correlation studies, direct and indirect methods, and identification techniques. (auth)

51755 (A/CONF.49/P–766) MANAGEMENT OF RADIOACTIVE WASTES AND THEIR LONG-TERM STORAGE. Sousselier, Y.; Pradel, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jul 1971. 17p. (CONF-710901–449). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A wide range of methods e.g., evaporation, coprecipitation, ion exchange etc., are presently used or under technological development for the treatment of the liquid wastes. Numerous studies with associated pilot tests have been conducted on high-level waste solidification by calcination, vitrification, etc. One problem, the disposal of tritium wastes, has not been satisfactorily solved. The management of solid wastes is fairly well known so that safe and economical results can be achieved by current processes for classifying, compacting, or solidification in concretes. However, the problem of disposal of gaseous effluents needs to be developed to meet the expected increase in effluent release. The main problem of the next ten years will be the choice of final disposal sites. The present practices (burial in the ground, and sea dumping) are certainly adapted to the quantities of wastes to be presently stored,

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and can probably be used in the near future for low activity wastes or short and medium lived radionuclides. But high activity or long lived radionuclide-containing wastes, such as plutonium, shall be disposed in convenient sites. Salt mines seem to provide the required criteria. However, deep injection into the soil will provide better means for disposal of certain categories of wastes. (auth)

51756 (A/CONF.49/P–770) DEVELOPMENT OF IAEA SAFEGUARDS SYSTEM FOR NPT. Rometsch, R. (International Atomic Energy Agency, Vienna (Austria)). Aug 1971. 14p. (CONF-710901–464). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Topics considered include the basis for the safeguard committee's work, the committee's working methods and results, and the need for future development. (D.H.M.)

51757 (A/CONF.49/P–771) SYSTEMS ANALYSIS IN SAFEGUARDS OF NUCLEAR MATERIAL. Haefele, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Jun 1971. 25p. (CONF-710901–452). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Traditional science deals with objective nature by applying mathematical models to it. Systems analysis intends to apply models, if possible mathematical ones, to the system composed of nature, men and its interactions including the operations of men. For that the system is defined by its objectives and constraints. In that approach operations research is a subset to systems analysis. Having implicitly or explicitly this approach in mind only a few papers exist that deal with the design of such an overall system. A logical scheme for a systems analysis, if complete, is elaborated and explained in detail. It places the definition of the objective, the description of the fuel cycle, the collection of information, its effect on the inspector as well as the operator and the strategies and operations of these parties in the logical perspective of the safeguard systems designer. Having clarified the long-range systems analysis task by this explanation, the scheme is then used to assess the function and position of the various contributions to systems analysis. Attention was given, in particular, to the results of the IAEA panels on system analysis and safeguards methods and techniques as well as to the partly implicit considerations for the establishment of the now proposed safeguard system. Finally, the large number of single and more detailed contributions are reviewed against the above mentioned logical scheme. It becomes apparent that a few areas are well covered and understood whereas other areas are only slightly or not at all covered. It is possible to identify a few headlines that cover most of the analysis work done so far. In line with that special attention will be given to material unaccounted for (MUF). (auth)

51758 (A/CONF.49/P–773) TECHNICAL BASIS FOR INTERNATIONAL SAFEGUARDS. Gmelin, W.; Hough, G.; Shmelev, V.; Skjoeldebrand, R. (International Atomic Energy Agency, Vienna (Austria)). Jul 1971. 23p. (CONF-710901–453). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The technical safeguards objectives and the resulting verification requirements of an international system to meet the obligations arising from the Non-Proliferation Treaty are presented. The verification procedures that can be applied by the international system to material flows and inventories of the three types of facilities, using independent measurements complemented by containment and surveillance measures to achieve quantified accountability levels are considered. The technical impact of the desired level of accountability, the amounts of flow and inventory, the point and the use of statistical sampling on the allocation of inspection effort is considered. Safeguards techniques that need to be developed, in particular in connection with independent measurements, the application of item accountability based on reactor fuel assemblies, and the use of isotopic correlation data are also considered. (auth)

51759 (A/CONF.49/P–809) INSTRUMENTED NUCLEAR MATERIAL ASSAY FOR SAFEGUARDS. Baeckmann, A. v.; Kuechle, M.; Weitkamp, C.; Avenhaus, R.; (and others) (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). Apr 1971. 15p. (CONF-710901–337). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Activities in the field of instrumented methods for nuclear material assay under way in the Federal Republic of Germany are summarized. Both destructive and nondestructive techniques are described. The development of direct methods is dominated by the automation of mass spectrometric determination of isotopic composition and concentrations of uranium and plutonium, and the measurement of U and Pu concentrations by x-ray fluorescence spectrometry. While a fully automated system for x-ray fluorescence analysis will be available by the end of 1971, the development of the mass spectrometric method has so far been limited to the automation of the spectrometer itself. Automatic sampling and chemical processing are expected to be ready for use by 1973. A comprehensive comparative analytical program was performed in collaboration with several international laboratories. Results are indicated and discussed. Indirect methods cover a variety of instruments that have been built for plant application, namely calorimeters, slowing-down spectrometer, and a delayed-neutron analyzer. Several types of calorimeters for the assay of Pu have been built and successfully used at the ALKEM fuel element fabrication plant. Calorimetry is supplemented by neutron measurements. For separate assay of ^{239}Pu and ^{235}U in fuel pins the slowing-down spectrometer is used. Equipment for routine industrial application was developed at INTERATOM. The delayed-neutron technique for assay of highly enriched nuclear fuels was applied at the University of Hannover. Operation and data acquisition and reduction are fully automated. Subthreshold neutron-induced fission measurements using a Sb-Be neutron source can be used for nondestructive fissile material assay of low-enrichment fuels. Investigations on the feasibility of this technique were conducted. The fundamentals for assay of individual isotopes in nuclear fuel by gamma-ray spectrometry following neutron capture were developed at Karlsruhe. (auth)

51760 (A/CONF.49/P–828) REVIEW ON THE NATIONAL SAFEGUARDS SYSTEM IN JAPAN AND ITS SYSTEM STUDY. Tamiya, Shigefumi; Oshima, Keichi; Imai, Ryukichi (Japan Atomic Power Co., Tokyo). May 1971. 30p. (CONF-710901–348). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The current status of implementation of the national safeguards system in Japan is summarized. Since the establishment of the Atomic Energy Basic Law in 1955, the Japanese government has succeeded in assuring that the nuclear material is only used for peaceful purposes. For this purpose, the Law for Regulation of Nuclear Material and Reactors was established. In accordance with that law, several control measures including the design review of nuclear facilities, review of records and reports system, and verification by Japan Atomic Energy Bureau were performed for all nuclear material in Japan. Secondly, the Japanese policy on the rationalization of the safeguards system for Japan with relation to the NPT is summarized, and the research and development activities on safeguards technology are outlined. The systems study of national safeguards system is discussed. The aim of this study was to evaluate the nuclear material control system from the viewpoint of cost-effectiveness. As a basis of systems approach, a macro-model of the whole national fuel cycle of Japan from 1970 to 1980 was constructed. A micro-model on the flow of nuclear material in the individual facilities was constructed. Using output data from this model, the flow of materials through strategic points and the inventory in the facility was constructed. Based on the output of these models, the costs and effects of various safeguards measures were analyzed. Combining the above results, the cost-effectiveness of the proposed national nuclear materials control system was studied with special consideration for the consistency of effectiveness in different facilities. (auth)

51761 (BNWL-SA-3904) SAFEGUARDS SYSTEMS CONSIDERATIONS. Schneider, R. A.; Granquist, D. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 15 May 1971. Contract AT(45-1)-1830. 15p. (CONF-710606–3). Dep. NTIS.

From seventeenth annual meeting of the American Nuclear Society; Boston, Mass. (13 Jun 1971).

The systems aspects of safeguards are discussed in terms of the elements of a safeguards system, the factors which influence the extent and manner in which the various elements are applied, and how these elements are employed in specific cases. (L.C.L.)

51762 (CEA-CONF–1786) PLANTS FOR TREATMENT OF ENRICHED URANIUM AT CADARACHE. Corpel, J. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Jun 1970. 7p. (In French). (CONF-700657–1). Dep. NTIS (U. S. Sales Only).

From Conference on experience of organization subject to nuclear safeguards inspection; London, England (1 Jun 1970).

There are 4 enriched uranium plants at Cadarache. Two are used for the conversion of UF$_6$ to oxide or metal, and 2 are used for the recovery of wastes. Since their commissioning at the end of 1964, 10 Euratom and 5 USAEC inspections have taken place. The inspection of the accountable inventory has never presented any difficulty. The physical inventory is, in general, limited to the verification of gross weight of solutions or solids. In the course of 15 inspections, the representatives of Euratom and the USAEC have only taken 2 samples. (auth) (France)

51763 (CONF-710617-26) INSTITUTE OF NUCLEAR MATERIALS MANAGERS INVENTORY CONTROL: THE FINANCIAL SIDE OF THE PROBLEM. **Samuelson, D. C. (Price Waterhouse and Co., New York). 1971. 15p.**

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The inception of private ownership of special nuclear materials has added two aspects to nuclear materials inventory control. These financial aspects are the necessity for controlling the monetary value of nuclear materials in inventory and the recognition of the time value of money tied up in inventories. Methods for accounting for and controlling inventory values and for minimizing inventory costs are discussed. (L.C.L.)

51764 (HEDL-SA-123) MOCK-UP SAMPLER FOR RADIOACTIVE SODIUM FROM FAST FLUX TEST FACILITY. **Knoll, K. C.; Scott, F. A. (Hanford Engineering Development Lab., Richland, Wash.). [nd]. Contract AT(45-1)-2170. 28p. (CONF-710606-7). Dep. NTIS.**

From 17th annual meeting of the American Nuclear Society; Boston, Mass. (13 Jun 1971).

A remotely operable sodium sampler which meets the criteria needed to provide a valid analytical sample is described. The sampler is designed so that it can be used to leak check the sample tubes and to seal and remove them using master-slave manipulators. The samples were taken at the temperature of the system and were of adequate size for the necessary analysis and archive purposes. The samples were cooled rapidly and uniformly so that longitudinal segregation of the only impurity examined, oxygen, was not a problem. The use of the double crimp to seal the sample tube permits the sample to be taken in air or a badly contaminated inert atmosphere without danger of sample contamination. The experience gained with this equipment demonstrates that it is feasible to sample the radioactive sodium of FFTF by the removable section technique and that a reliable representative sample can be obtained. (auth)

51765 (JPRS-53800, pp 4-23) HOT MATERIALS RESEARCH LABORATORY OF THE INSTITUTE OF ATOMIC REACTORS. **Bazyukin, V. G.; Votinov, S. N.; Golovchenko, Yu. M.; Davydov, E. F.; Dem'yanovich, M. A.; Zebarev, A. I.; Klimenkov, V. I.; Leonov, V. N.; Chushkin, Yu. V. Translated from pp 5-22 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.**

A description is given of the equipment and potentialities of the laboratory. The measurements carried out in the SM-2 reactor and its use in neutron diffraction are also discussed. The groups using the laboratory are described, and its five-year operation is examined. (D.L.C.)

51766 (LA-4705) NUCLEAR SAFEGUARDS RESEARCH AND DEVELOPMENT. **Program Status Report, January-April 1971. (Los Alamos Scientific Lab., N. Mex.). May 1971. Contract W-7405-eng-36. 35p. Dep. NTIS.**

The status of LASL research on nuclear materials safeguards is reported. Information is included on: neutron interrogation and nondestructive assay of fissionable materials; radioisotope sources for nondestructive assay uses; passive neutron and gamma-ray assay applications; detector and instrumentation development; analytical studies and computational methods; and the Mobile Nondestructive Assay Laboratory (MONAL). (L.C.L.)

51767 (LA-DC-12294) RADIOACTIVE SOURCES FOR SAFEGUARDS, MATERIALS MANAGEMENT AND PROCESS CONTROL. **Menlove, H. O.; Forster, R. A.; East, L. V.; Foley, J. E. (Los Alamos Scientific Lab., N. Mex.). [1971]. 21p. (CONF-710617-35). Dep. NTIS.**

From twelfth annual meeting of the nuclear materials management; West Palm Beach, Fla. (29 Jun 1971).

The use of radioactive neutron sources for the nondestructive assaying of fissionable materials, particularly for in-plant measurements and quality control of reactor fuel components, is discussed. The primary variables to be considered in the application of radioactive sources to a given measurement problem are: type of neutron source; the moderator and shield for the source; and the detector for counting the induced neutrons and/or gamma rays. Examples of assay systems and applications are presented and include the ^{252}Cf fuel rod assay system and the use of coincidence counting in the random source neutron interrogation of materials containing ^{240}Pu and ^{238}U. It is concluded that a given nondestructive assay problem requires optimization of the neutron source, moderator, and detector. Due to the complexity of the problem, strong calculational capability is needed to make preliminary evaluations on the combinations of these three sets of variables. Because of the simplicity and reliability of radioactive neutron sources, they will play an important role for in-plant measurements of fissionable materials and quality control of reactor fuel components. However, for samples which have high neutron backgrounds or for large containers (e.g., scrap barrels), the relatively high neutron intensity and irradiation flexibility of accelerator-type sources are required. (L.C.L.)

51768 (LA-DC-12295) PASSIVE ASSAY: INNOVATIONS AND APPLICATIONS. **Parker, J. L.; Reilly, T. D.; Foley, J. E.; Walton, R. B.; East, L. V. (Los Alamos Scientific Lab., N. Mex.). [1971]. Contract W-7405-eng-36. 33p. (CONF-710617-25). Dep. NTIS.**

From twelfth annual meeting of the nuclear materials management West Palm Beach, Fla. (29 Jun 1971).

Recent work at LASL on the development and use of several methods of passive nondestructive assay are described. Both gamma-ray and neutron systems for assay of Pu and U isotopes are discussed. Information is included on general considerations for gamma scanning systems, a specific gamma scanning system for drums up to 55 gal., Pu isotope analysis using high-resolution gamma-ray spectroscopy, gamma-ray assay of ^{238}U, and development of passive neutron assaying for Pu and U. (L.C.L.)

51769 (LA-DC-12296) FIELD ASSAY EXPERIENCE WITH THE MONAL AT NATIONAL LEAD COMPANY OF OHIO. **Menzel, J. H.; Teilly, T. D.; Dennis, B. R.; Parker, J. L.; Foley, J. E. (Los Alamos Scientific Lab., N. Mex.); Gessiness, B.; Diehl, A. R.; Humphrey, H. W. (National Lead Co. of Ohio, Cincinnati). [nd]. Contract W-7405-eng-36. 26p. (CONF-710617-19). Dep. NTIS.**

From twelfth annual meeting of the nuclear materials management West Palm Beach, Fla. (29 Jun 1971).

The AEC Feed Materials Production Center at Fernald, Ohio has a large scrap recovery plant which processes great quantities of clad and bare remeltable metal and residues of many types shipped from AEC contractors throughout the country. In order to perform more rapid, accurate, nondestructive assays on incoming scrap materials the Mobile Nondestructive Assay Laboratory (MONAL), operated by LASL, was brought to Fernald. 200 drums of incinerator oxide and ash received from a contractor were selected for ^{235}U assay. The MONAL equipment and procedures are described. The MONAL measurement of ^{235}U inventories are compared with the results of inventories based on weighing, sampling, and analyzing material from the drums. It was found that while overall inventories from the two methods may balance, the fissile material inventory in individual containers as measured by MONAL could differ significantly from directly measured values, and that the relatively rapid measurement rate on entire containers enables the nondestructive techniques to provide more complete, detailed information on a larger number of samples and thus keep tighter control on fissile material inventories. This information is significant for criticality safety and for safeguards purposes. (L.C.L.)

51770 (STI/PUB-285) TESTS ON TRANSPORT PACKAGING FOR RADIOACTIVE MATERIALS. **Proceedings Series. Proceedings of a Seminar Held in Vienna, 8-12 February 1971. (International Atomic Energy Agency, Vienna (Austria)). May 1971. 650p. (In several languages). (CONF-710210). IAEA $18.00.**

Forty papers on the testing of containers for shipping radioactive material were presented at the conference. A separate abstract was prepared for each of 37. Three papers appeared previously in NSA. For abstracts of these see CONF-710210 in the report number index. (L.C.L.)

For abstracts of individual papers see: 51805–51841.

51771 (TID-25729) ENVIRONMENTAL STATEMENT RADIOACTIVE WASTE REPOSITORY, LYONS, KANSAS. **(Atomic Energy Commission, Washington, D. C.). Jun 1971. 222p. Dep. NTIS.**

The multiple effects of Project Salt Vault on the environment near Lyons, Kansas were examined. These effects are categorized as ecological, geophysical, physiological, radiological, sociological, and thermal. A value assessment of the short-term uses and long-term consequences of Project Salt Vault concluded that during the minimum of 25 years of operation of the repository, portions of the surface area could be put to beneficial use such as a site for an industrial park or might be revegetated to natural prairie. Following the decommissioning of the repository and sealing of the mine, essentially all of the surface could be returned to virtually unrestricted use subject, of course, to restrictions on deep drilling activities. It is planned that the site will be maintained in the perpetual care of the Federal Govern-

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ment to provide for continuity of the post-operational monitoring program, and to maintain the integrity of the underground workings thereby assuring the continued isolation of these wastes from the biosphere. Finally, US salt reserves are of such magnitude that the use of this particular deposit as a waste repository will have little effect on salt production, and the removal of 1000 acres from agricultural uses should cause no detrimental impact on local agricultural production or national needs. (L.C.L.)

51772 (WASH-1163) EXPORT AND IMPORT OF MATERIALS AND FACILITIES CONTROLLED BY THE ATOMIC ENERGY COMMISSION. A Guide to AEC Export and Import Regulations. Saltzman, Jerome (comp.) (Division of State and Licensee Relations (AEC), Washington, D. C. Indemnity and Export Control Branch). [nd]. 75p. Dep. NTIS.

A digest is presented of USAEC regulations for the export and import of materials and facilities controlled by the AEC. These materials include: radioisotopes; source material, i.e., Th and U in any form; ^{233}U, uranium enriched in ^{235}U, and Pu. The facilities covered include any nuclear reactor and any large-scale facility for separating Pu or U isotopes. This handbook was designed to be used as a working reference by Bureau of Customs officers, and is arranged in sections according to the material or facility to be exported or imported. Each section contains information on definitions, license requirements, and exemptions from AEC licensing authority. A supplement of general information and information on units of measure, use of AEC specific licenses to export, packaging and labeling, radiological emergency procedures, and an AEC assistance directory is included. (L.C.L.)

51773 SAMPLE VOLUME MEASUREMENT APPARATUS. Peray, Robert (to Commissariat a l'Energie Atomique). French Patent 2,033,523. 23 Nov 1970. Filed 26 Feb 1969. (In French).

An apparatus was designed to measure the volume of a radioactive sample. The device includes two transparent accurately calibrated capillary tubes, communicating at either end with two common reservoirs. The first leads through a hermetically closing trap to a measurement liquid intake funnel and an opening connected to a vacuum pump. The second contains an open part, able to cooperate with a sample-holder held against the reservoir. A vertical stand, mounted on a pivot which allows the tubes to tilt through 180°, supports the two capillary tubes and the two reservoirs. The apparatus includes an optical sighting system to read the liquid fluid level in the two tubes. The fluid consists of mercury or any other wetting or non-wetting liquid, particularly bismuth. (auth) (France)

51774 METHOD AND APPARATUS FOR DISPOSAL OF FISSION PRODUCTS. Bonniaud, Roger; Gougeard, Jean-Marie; Moulin, Jean; Reboux, Jean; Sombret, Claude (to Commissariat a l'Energie Atomique). British Patent 1,239,710. 21 Jul 1971. Priority date 7 Jul 1969, France.

Fission products may be incorporated into a leach-resistant vitrified mass for disposal by induction melting of the calcined fission products and materials to form a glass with the calcined products in a crucible of an electrically insulating refractory material. Periodically a volume of the glass is withdrawn from the bottom of the crucible by induction heating of a plug of the vitrified mass that normally closes a nozzle at the bottom of the crucible by induction heating of the plug. This allows the molten mass to fill a permanent storage container. The material added to the calcined products is a phosphate glass if the products contain Mo and a silicate glass if the products contain Al. (B.L.M.)

51775 MANIPULATOR ARM. Bridges, Robert Hurst. British Patent 1,237,749. 30 Jun 1971. Priority date 20 Jul 1967, United States.

A manipulator arm is described that is operated by hydraulic actuation and that is suitable for handling radioactive material in hot cells. Complete action is also accomplished with the elimination of the elbow joint without elimination of its functions. (B.L.M.)

51776 IMPROVEMENTS IN OR RELATING TO WRIST JOINTS FOR REMOTE CONTROL MASTER-SLAVE MANIPULATORS. (to Central Research Laboratories, Inc.). British Patent 1,236,006. 16 Jun 1971. Priority date 8 Nov 1968, United States.

A wrist joint for a remote control master-slave manipulator includes a two part housing, a number of take-up means for linear motion transmission elements being journaled for rotation within the first part of the housing, and gear means connected to each of the take-up means. Each gear means is operatively connected to a respective one of a number of further gears journaled in the second housing portion. These further gears are operatively connected to motion transmitting means carried by the second housing portion. Each of the take-up means in the first housing is independently rotatable and each has a pair of circumferential channels adapted to receive the linear motion from the motion transmission elements. Both parts of the housing are secured together in such a way that the portions together with the mechanisms contained in them are separable. (B.L.M.)

51777 GRASPING IMPLEMENT. (to Universal Technical Products, Inc.). British Patent 1,229,986. 28 Apr 1971. Priority date 23 Jun 1967, United States.

A grasping implement is comprised of an elongated casing provided at one end with an aperture and at least two elongated spring fingers slidable within the casing and capable of being moved so that a predetermined length of the spring fingers projects externally through the aperture. Each spring finger is preformed to assume a nonlinear configuration when unconstrained so that projecting portions of the spring fingers flex outwardly from the axis of the casing during the movement of the spring fingers. The implement is adapted to picking up and manipulating thin, small, delicate, hot, sterile, radioactive, or oddly shaped objects. (B.L.M.)

51778 RESULTS OF THE OPERATION OF PROJECT SALT VAULT: A DEMONSTRATION OF DISPOSAL OF HIGH LEVEL RADIOACTIVE SOLIDS IN SALT. Empson, F. M.; Bradshaw, R. L.; McClain, W. C.; Houser, B. L. (Oak Ridge National Lab., Tenn.). pp 455-62 of Third Symposium on Salt. Vol. 1. /Rau, Jon L. (ed.). Cleveland; Northern Ohio Geological Society, Inc. (1970).

From third international symposium on salt; Cleveland, Ohio (22 Apr 1969). See CONF-690456-(Vol.1).

Disposal of high-level solid radioactive wastes from the processing of spent reactor fuels is of considerable interest in the development of a nuclear power industry. A demonstration of the disposal of high-level radioactive solids has been successfully completed in salt of the Hutchinson Member of the Wellington Formation at the inactive mine of the Carey Salt Company near Lyons, Kansas. Approximately 4,000,000 curies of radioactive material (as encapsulated Engineering Test Reactor fuel assemblies) were shipped from the National Reactor Testing Station near Idaho Falls about 1100 miles to the Lyons mine, transferred to mine level (1000 ft below the surface), and placed in experimental disposal holes. At the end of the testing period, the canisters were removed from the mine and returned to Idaho. Operations at Lyons were carried out without the use of hot cells. Maximum radiation exposure for any personnel was 200 mrem per quarter, principally to the hands. Average radiation dose to the salt over the length of the holes was about 8×10^{8} rads, and the peak dose was about 10^{9} rads. The peak temperatures reached 200°C adjacent to the holes. The structural properties of salt did not appear to be altered by the high doses and dose rates. The extensive heating of the salt around the test holes did produce effects not completely anticipated. These results included: the migration of small intercrystalline brine inclusions along thermal gradients and the transfer of thermal stresses over seemingly extraordinary distances. (auth)

51779 PROCEEDINGS OF THE 18th CONFERENCE ON REMOTE SYSTEMS TECHNOLOGY, WASHINGTON, D. C., NOVEMBER 1970. Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970). 236p. (CONF-701132).

Thirty papers are included under the following headings: hot cell operation and experience, fire prevention and control in remote facilities, facilities for shielded operations, systems for remote handling and viewing, and remote handling in the 1970's and beyond. A separate abstract was prepared for each paper. (M.C.G.)

For abstracts of individual papers see: 51379, 51683, 51780–51804, 51950, 52492, and 53458.

51780 PRESENT STATUS OF POSTIRRADIATION EXAMINATION FACILITY OF JAPAN ATOMIC ENERGY RESEARCH INSTITUTE. Homma, S.; Ito, H.; Yoshida, M.; (and others) (Japan Atomic Energy Research Inst., Tokai). pp 3-11 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

Ten years experience has been gained with the postirradiation examination of nuclear fuels and reactor structural materials in the Tokai Hot Laboratory of the Japan Atomic Energy Research Institute. Surveillance tests of fuel elements of JRR-2, JRR-3, JPDR, and the Tokai Power Reactor, and examinations of fuel specimens including plutonium-bearing oxide have been performed during the past decade. The postirradiation examination facilities, in-cell equipment procedures and techniques used, safety control, and administration are described. (auth)

51781 ENTERING A HOT CELL AFTER SIX YEARS OF REMOTE SPENT-FUEL PROCESSING. Paige, D. M.; Kinkade, K. H. (Argonne National Lab., Idaho Falls, Idaho). pp 12-18 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

After six years successful operation of a hot cell used as part of a direct fuel-reprocessing cycle, it became desirable to enter the cell for maintenance work. The cell was remotely and directly decontaminated to a level where a man could work for 2 hr and receive only 0.025 to 0.100 rad. This job required the efforts of 70 people directly associated with processing and the assistance of many others at the EBR-II site. (auth)

51782 CONTACT MAINTENANCE AND EQUIPMENT EVALUATION AFTER SIX YEARS OF CONTINUOUS REMOTE OPERATION INSIDE A HOT CELL. Kinkade, K. H.; Paige, D. M. (Argonne National Lab., Idaho Falls, Idaho). pp 19-25 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

After six years of continuous remote operation of the Fuel Cycle Facility, contact maintenance and equipment evaluation were performed on all air cell equipment that was not removable and not repairable by remote methods. The major pieces of equipment maintained were the 5-ton overhead crane and the two electromechanical manipulators. At the same time, evaluation was made of component parts consisting of electrical brushes, bus bars, springs, lubrication, wiring, gears, and wheels. (auth)

51783 INTERIM EXAMINATION OF EBR-II EXPERIMENTAL IRRADIATIONS AT THE FUELS AND EXAMINATION FACILITY. Hagmann, D. B.; Bacca, J. P.; Fieldman, M. J. (Argonne National Lab., Idaho Falls, Idaho). pp 26-35 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

The Fuels and Examination Facility (a four-cell complex) associated with EBR-II is the prime LMFBR programs irradiation and examination facility. Many of the 1227 experimental fuel elements and capsules presently in the EBR-II core will be removed from the reactor for an interim examination. Interim examinations provide several data points during the irradiation program for a single experiment. Dimensional checks, gamma scanning, neutron radiography, and weight determinations are a few of the nondestructive examinations that can be performed, as well as special examinations requested by experimenters. New equipment is being developed to provide faster and more accurate test results. (auth)

51784 WESTINGHOUSE PLUTONIUM FUELS DEVELOPMENT LABORATORY DESIGN PHILOSOPHY AND STARTUP EXPERIENCE. Olson, R. E.; Nardi, A. J. (Westinghouse Electric Corp., Cheswick, Pa.). pp 36-40 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

The Plutonium Fuels Development Laboratory is a $3.5 million facility constructed and operated by Westinghouse Electric Corporation's Nuclear Fuel Division. Its purpose is to develop and demonstrate the skills and techniques required to fabricate plutonium-bearing fuel assemblies. Construction was completed in early 1969 and the fabrication of 734 plutonium-bearing fuel rods for a commercial PWR was completed in April 1970. The reference process is the fabrication of high density pellets from mechanically mixed PuO_2 and UO_2 powders. The PuO_2 is prepared by oxalate precipitation of plutonium from the nitrate solution. Containment of plutonium is provided by glove boxes and differential air pressure control. (auth)

51785 FIRE PREVENTION AND PROTECTION IN HOT CELLS. Hill, A. J. Jr. (Savannah River Lab., Aiken, S. C.). Contract AT(07-2)-1. pp 43-8 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

Fires or explosions in hot cells at atomic energy sites are potentially very serious because of the large quantities of radioactive materials that could be dispersed by destruction or breach of the protective containment. To develop improvements that could significantly reduce the risk of fires or explosions, a study was made of fires, explosions, and incidents with serious potential that have occurred in hot cells and glove boxes at atomic energy sites. The modes of initiation and propagation were identified, and preventive measures are suggested for each cause. Preventive measures can significantly reduce the potential for fires and explosions, but cannot eliminate the occurrence of operating errors nor the need for effective alarm and extinguishing systems. To establish guides for selecting automatic fire extinguishing systems for applications in hot cells, studies were made to establish characteristics and performance data on commercial detectors and the suitability of various extinguishing agents. An automatic extinguishing system was developed as a result of these studies. (auth)

51786 FIRE PROTECTION CRITERIA FOR NUCLEAR FACILITIES. Patterson, D. E. (Atomic Energy Commission, Washington, D. C.). pp 49-53 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

On May 11, 1969, a disastrous fire occurred in the plutonium fabrication facility at the U.S. Atomic Energy Commission's (AEC) Rocky Flats Plant. During the ensuing year a major review was conducted of all AEC facilities to determine those locations where a major fire or accident could occur and produce serious consequences. An ad hoc set of criteria was used to evaluate the facilities. The development of general criteria applicable to nuclear facilities will take a great deal of work by groups involved in nuclear facility operations. A review of the basic principles of fire prevention, fire suppression, and facility design points to the direction in which such criteria might be developed is given. (auth)

51787 RECENT IMPROVEMENTS IN FIRE SUPPRESSION AND CONTROL FOR GLOVE-BOX OPERATIONS AT ROCKY FLATS. Williams, A. K. (Dow Chemical Co., Golden, Colo.). pp 54-9 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

Studies of fire suppression and control have shown that careful attention must be given to materials of construction, the ventilation system, and the heat detection system, when designing a plutonium handling facility involving glove-box operations. In both laboratory and full-scale glove-box and filter experiments, various materials of construction were evaluated. A water spray curtain and baffle system upstream from the filters were found to be effective in decreasing air temperatures and removing smoke particles before reaching the filter face. Heat sensors also need to be considered as an integral part of the plutonium handling facility. Detectors used for either smoke or fire should be properly selected for the particular job and strategically placed for maximum effectiveness. (auth)

51788 FIRE PREVENTION AND CONTROL IN NUCLEAR AIR CLEANING SYSTEMS. Burchsted, C. A. (Oak Ridge National Lab., Tenn.). pp 60-8 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

Fires in nuclear containment systems present special problems because contamination release during the fire may be a greater hazard than physical damage due to the fire itself. Special attention must be paid to operating procedures, limitations on combustible materials in operating areas, and other means of preventing fire, and to means of protecting the highly vulnerable HEPA filters (which serve as the final barrier between contaminated spaces and the atmosphere) from damage due to flame, sparks, and smoke. Fire extinguishing systems, although highly desirable in the filter housing, should be considered as last ditch expedients rather than as primary elements of a fire control program. (auth)

51789 CONTAMINATION CONTROL OF SODIUM FIRES FROM LIQUID-METAL-COOLED REACTORS. First, Melvin, W. (Harvard Univ., Boston). pp 69-77 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

Although liquid-metal-cooled fast breeder reactors have a potential for great safety, a typical reactor handling large volumes of hot elemental sodium has been analyzed carefully to determine where leaks and spills are likely to occur; standby control methods have been recommended to prevent spread of airborne products, reduce reactor shutdown time, and minimize cleanup costs. Critical factors affecting the design of engineered controls for the containment of accidental sodium releases were temperature of the metal, oxygen concentration, size of the space into which the spill or leak occurs, rate of sodium escape, and most importantly, the amount of sodium likely to be released before it can be stopped. (auth)

51790 IN-CELL CRANE, MANIPULATOR, AND TELEVISION SYSTEMS FOR THE THORIUM–URANIUM RECYCLE FACILITY (TURF). Beckers, R. M.; Shepherd, D. M. (Oak Ridge National Lab., Tenn.). pp 81-92 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

The Thorium–Uranium Recycle Facility (TURF) contains a four-cell complex which is served by a crane and monorail system, an electromechanical manipulator system, and a television system. A transfer unit provides two-level operation and translation through shield-door openings for inter-cell transfer of crane bridges and loaded crane hoists. Electromechanical manipulators are transferred between cells by the crane hoists. In-cell equipment is designed for washdown, radiation resistance, fail safe operation, and remote retrieval. Three other cells contain two bridge cranes and two manipulators that are maintained by direct and semi-remote techniques. (auth)

51791 DESIGN AND INSTALLATION OF THE TURF CALIFORNIUM FACILITY. Peishel, F. L.; Burch, W. D.; Jarvis, J. P. (Oak Ridge National Lab., Tenn.). pp 93-100 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

A facility to ultra-purify ^{252}Cf, prepare neutron sources from the californium, and recover pure ^{248}Cm, the alpha decay daughter of ^{252}Cf, was installed in an existing 16- by 20-ft cell of the TURF facility of ORNL to satisfy requirements for the heavy element production program. The $5\frac{1}{2}$-ft-thick concrete walls contain two zinc bromide windows in each of three walls and a pair of master-slave manipulators at each window. Three window positions were equipped with 6- × 6-ft work stations, two for chemical separations work and one for the source fabrication equipment. All the structural and processing equipment installed in the cell was designed for remote installation and removal. (auth)

51792 TRANSFER OF CALIFORNIUM SOURCES BY PNEUMATIC RABBIT. Jarvis, J. P.; Burch, W. D.; Chandler, J. M. (Oak Ridge National Lab., Tenn). pp 101-6 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

Pneumatic transfer of ^{252}Cf sources and shipping containers is replacing the more costly and time-consuming method of shielded carrier transport of these sources between two facilities at ORNL where californium is handled. These facilities, the Transuranium Processing Plant (TRU) and the Thorium Uranium Recycle Facility (TURF), are adjacent to each other. The transfer tube is a 1-in. stainless-steel pipe, approximately 700 ft long. Schemes have also been worked out to transfer sources from off-site carriers to hot cells by similar means, either as a convenience, or for users of ^{252}Cf sources who do not have adequate crane capacity and head room to handle the carriers. (auth)

51793 PNEUMATIC TUBE TRANSFER SYSTEM FOR RADIOACTIVE SAMPLES. Ludlow, J. O. (Catalytic, Inc., Philadelphia); Slawecki, M. A.; Brown, H. L. pp 107-15 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

A pneumatic tube transfer system for the movement of radioactive samples some 2000 ft between a shielded, inert atmosphere, preparation facility, and an analytical instrument complex dry box, has been built and operated. The system is unique in its operation, using helium below atmospheric pressure as the carrier gas, and is completely self contained. The two enclosed atmosphere areas, which are contaminated with radioactive materials (including plutonium), contain separate atmospheres and are maintained at separately controlled pressures. Operation of the transfer system is accomplished without either cross-contamination of the two enclosure atmospheres or the necessity to handle large amounts of contaminated helium gas. (auth)

51794 DRILL CORE PROCESSING FACILITY. Moore, Philip F. (Los Alamos Scientific Lab., N. Mex.). pp 116-24 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

A facility has been built at Los Alamos for the processing of underground nuclear test samples to prepare them for radiochemical analysis. In addition to the glove box and hood lines for this processing, rooms have been provided for sample receiving and handling, equipment decontamination, radioactive storage, and other service functions, plus an aliquot room and a laboratory designed for special semi-remote chemistry operations. Extensive radiation shielding for personnel is employed at all hoods, glove boxes, and aliquot benches. (auth)

51795 SMALL HOT CELL CHEMISTRY PLANT. Barnes, John W. (Los Alamos Scientific Lab., N. Mex.). pp 125-31 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

A small chemistry plant to process radioactive debris from underground nuclear tests has been assembled and operated in the J-11 Hot Cells at Los Alamos. The operations involved include physical concentration, combined grind and leach, distillation, filtration, and centrifugation. Distillation equipment, centrifuge bottles, and the grind-leach vessel were made from polypropylene labware by welding. Valves and tubing were PVC and polypropylene. A Teflon and Kel F distillation apparatus was devised for evaporation of perchloric acid. The vigorous agitation needed for the grind-leach step was obtained using a paint mixer. Metering and hazard warning systems were devised for handling HF. (auth)

51796 HOT CELL STEREOMACROSCOPE AND POSITIONING STAGE FOR VIEWING OBJECTS IN EITHER A HORIZONTAL OR VERTICAL PLANE. Carnes, M. D. (Argonne National Lab., Idaho Falls, Idaho). pp 148-52 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

Nondestructive examination of experimentally irradiated materials from EBR-II requires visual inspection with depth perception. The operational requirements of EBR-II dictate that many of the capsules and elements be examined in a vertical position. Some, however, can better be examined in a horizontal position. To satisfy these requirements, a biplanar stereomacroscope and positioning stage were provided to allow inspection of objects in either vertical or horizontal planes. (auth)

51797 MOCKUP OF REMOTELY OPERATED HIGH-PURITY INERT-ATMOSPHERE SODIUM ANALYSIS FACILITY. Lust, L. F.; Scott, F. A.; Jarosch, J. F. (Battelle-Northwest Richland, Wash.). pp 153-8 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

The Fast Flux Test Facility (FFTF) will require chemical characterization of the highly radioactive sodium coolant. One possible way to obtain this characterization is by sampling and laboratory analysis. Since no remotely operated facilities have been developed that have an atmosphere of sufficient purity to permit the analysis of metallic sodium, new technology is required. To aid in the development of this technology, a special mockup facility was constructed at PNL. A hermetically sealed cell was constructed of stainless-steel plate. It was furnished with sealed master-slave manipulators, an evacuable air lock, a viewing window, and a recirculating gas purification system. Using an argon purge, an atmosphere containing <1-ppM oxygen and 0.5-ppM water was attained. The quality of the atmosphere was continuously monitored for two months, during cell operation, and the ability to maintain this purity level was demonstrated. Results of determinations of oxygen in sodium, performed in the remote facility, are comparable to those obtained in conventional sodium analysis facilities. Sufficient information has been obtained to predict with a high degree of certainty that highly radioactive sodium can be analyzed by conventional procedures if the proper facilities are available. These facilities can be constructed with commercially available components and proven construction techniques. (auth)

51798 ARGON ATMOSPHERE FILTER SYSTEM IN HFEF HOT CELL. Swanstrom, R. H.; Hirsch, P. R. (Argonne National Lab., Ill.). pp 159-61 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

Filters in the main cell of the Hot Fuel Examination Facility (HFEF) reduce the level of radioactive contamination in the out-of-cell equipment. The filter assembly has been designed to permit filter replacement by remote control and the handling method has been successfully demonstrated in a mockup. Tests have been made to verify the radiation resistance of the filter and gasketing materials. (auth)

51799 SHIELDED NEUTRON SHIPPING CASK. Hanson, C. L. (Univ. of California, Livermore); Coops, M. S.; Arnold, E. D. pp 162-8 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

A shielded neutron shipping cask was designed to transport 3-g_m quantities of ^{252}Cf. The cask weighs 25 tons and may be shipped by common carrier anywhere in the United States. Neutron sources will be packaged in all-metal pressure vessels suitable for use at 1500°F. Three source vessels, each 3 in. in diameter × 12 in. long, may be stored in a rotating magazine at the center of the cask. An 8-ft-long plug with grapple fingers locks the magazine during transport and is also used to remotely load or unload the neutron-source vessels. A Boral plate is used to absorb slow neutrons and a steel billet provides primary-gamma shielding near the center of the cask. The neutron shield consists of borated limonite concrete and borated gypsum cast into the cavities formed by two concentric steel shells. (auth)

51800 TRIGGER-ACTUATED MOTION LOCKS FOR MASTER-SLAVE MANIPULATORS. Coops, M. S.; Stearns, E. H.; Hanson, C. L. (Univ. of California, Livermore). pp 169-73 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

Several types of rapidly actuated and released motion-lock mechanisms have been constructed for use with conventional mechanical master-slave manipulators. All these units use compressed-air-driven, short-stroke pistons to supply the locking force for each motion. Reaction times for activation and release are typically a fraction of a second, and are controlled by the normal selector switch trigger mounted on the master hand. All motions are rigidly locked, or released, with one simple finger movement by the operator. (auth)

51801 WHERE DO WE GO FROM HERE WITH MASTER-SLAVE MANIPULATORS. Jelatis, Demetrius, G. (Central Research Labs., Inc., Red Wing, Minn.). pp 191-5 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

A description of the basic attributes of master-slave manipulators is presented along with an account of development of mechanical master-slaves at Argonne National Laboratory (ANL) and at Central Research Laboratories, Inc. (CRL). The broad fields of current utilization of master slaves and the reasons for their use are set forth. A statement of the state-of-the-art in servo-coupled master slaves is followed by an assessment of potential developments. A speculative look at potential applications and problems leads to a concluding admonition to heed the economic and social consequences of developments in this field. (auth)

51802 DISPOSABLE ALPHA-GAMMA TRANSFER CONTAINER. Lazarus, M. E.; Montgomery, C. D. (Los Alamos Scientific Lab., N. Mex.). pp 209-10 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

A system for transferring materials into and out of alpha-gamma cells using polypropylene cans and polycarbonate lids is described. A metal shell is used to support the container sides. The plastic containers are disposable. (J.R.D.)

51803 CONTROLLED-LEAK CAPSULE TO CONTAIN INTENSE ALPHA EMITTERS. Youngquist, C. H. (Argonne National Lab., Ill.). pp 211-12 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

A capsule for containment of neutron sources composed of powdered Be$-$Cm$_2$O$_3$ mixtures is described. The capsule incorporates a leak plug designed to release helium produced by Cm decay. (J.R.D.)

51804 ONE-GALLON TRANSFER SYSTEM. Buzzell, J. A.; Harvey, H. W. (Argonne National Lab., Ill.). pp 213-14 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

Design and operation of an inexpensive transfer system for remote operation in containment boxes for highly radioactive alpha emitters are described. Readily available components are used and minimum fabrication effort is required. Photographs of the equipment are included. (J.R.D.)

51805 DEVELOPMENT AND ADEQUACY OF THE TEST REQUIREMENTS FOR PACKAGING FOR THE TRANSPORT OF RADIOACTIVE MATERIALS. A REVIEW. Fairbairn, A. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 3-17 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

After emphasizing the importance of the packaging tests in ensuring that the requisite safety features built into the design of packages comply with the Agency's Regulations, the historical background of the tests is summarized. The broad definitions of Types A and B packaging established for the 1961 IAEA Regulations, together with work sponsored by the International Standards Organization, led to the submission of proposals for packaging tests to the Panels responsible for the first revision of these Regulations. These proposals, together with other practical studies, led to the prescription by the Packaging Panel of the tests as set out in the current Regulations. The formal proposals for the current revision of the Regulations, which formed the basis of the Panel work in February 1970, included relatively few and minor proposals for amendment of the tests; consequently, few actual changes to the tests are given in the draft revision dated November 1970 and now issued for formal comment. Further revision of the tests during the Panel meeting provisionally arranged for October 1971 is emphasized. Following a review of the objectives underlying the prescription of the test requirements and taking Type A and Type B tests in turn, certain problems resolved by the Packaging Panel and resultant questions which require critical review in the light of experience to-date are discussed. Besides questions to help ensure that adequate attention is paid to the Type A tests, questions for discussion in respect of the Type B mechanical and thermal tests, laying particular stress on the use of calculations and model tests are listed. After stressing the need for discussion of matters relevant to both the preparation of a package for testing and its assessment after test, a review of the arrangements made to collect and collate data from serious transport accidents is recommended. (auth)

51806 ACCIDENT EXPERIENCE WITH TYPE B PACKAGING IN THE UNITED STATES OF AMERICA. Grella, A. W. (Dept. of Transportation, Washington, D. C.). pp 29-50 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

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The transport of radioactive materials in the US, which, essentially, began less than three decades ago, has increased steadily, especially over the past ten years. Whereas by far the greater number of shipments has been, and will continue to be, of the smaller Type A packagings, the number of Type B package shipments, including large source and irradiated fuel casks, is expected to increase very significantly in direct proportion to the current rate of growth of the nuclear power industry. Examination of information on transport accident experience in the US reveals that no shipments of spent-fuel casks have ever experienced severe impact or fire. The number of known transport incidents wherein any Type B packagings have been subjected to accident conditions resembling the Type B test criteria is very small. Details of the few such incidents are discussed, including a recent accident in which several "wooden overcoat" Type B packages were involved in a severe accidental fire, which appeared to have simulated quite closely the hypothetical fire parameter of the Type B tests. Accident experience information from a few other non-radioactive material package accidents, in which the conditions of the accident appeared to be quite similar to the Type B test conditions is also presented. (auth)

51807 CONSIDERATIONS ON DROP TESTS. Sousselier, Y.; Redon, A. (CEN, Fontenay-aux-Roses, France). pp 53-63 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971). (In French).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

Over the years accidents involving small consignments comprising Type A packaging seem to indicate that the risk of their being crushed is the least probable one (fall of a package during handling, fall of a lift-truck which crushes package). Existing tests seem to us insufficiently informative in this matter. For example, radioisotope packaging with "can"-type containers placed in cardboard boxes easily withstands existing tests (it even withstands a fall of much more than 1.20 m), but can easily be damaged when crushed by a lift-truck or trolley. It also seems that these considerations do not apply to Type A packaging only and that it is doubtful whether existing mechanical tests for light Type B packaging are, in fact, satisfactory. Light Type B packaging can withstand a free fall of 9 meters and the 1-meter punch test, but, on the other hand, it offers no resistance to crushing or puncture by a heavy load. It might therefore be advisable for the present punch test to be restricted to packages of a certain minimum weight, in conjunction with a minimum mean density limit, and that a more developed punch test and test for crushing by a heavy load should be introduced for packages which do not fall within these limits. (auth)

51808 ANALYSIS OF DESIGN AND TEST REQUIREMENTS AND PROCEDURES FOR TYPE A PACKAGING. Domanus, J. C. (Danish Atomic Energy Commission, Risoe, Denmark). pp 65-91 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The design and test requirements for Type A packagings in all international (IAEA, IATA, RID, IMCO, ADR, ISO) and national (e.g., US, UK, France) regulations and standards are analyzed and listed together with the procedures. Reports of testing performed by various national (Australia, Canada, France, Fed. Rep. Germany, Sweden, UK, US) and international (EURATOM) bodies, reports presented at international symposia and propositions for amendments to the IAEA Regulations were studied and suggestions for additional testing are given. Special equipment for testing was designed and constructed. Eighteen different kinds of Type A packaging currently in use in Denmark and several Type A packagings from other countries were tested according to the IAEA Regulations; additional testing suggested elsewhere (IATA, suggestions for the amendment of the IAEA Regulations) was also applied. Separate testing was performed on some elements and materials used in the Danish Type A packaging. On the basis of these test results, Danish Type A packagings were redesigned and tested again to demonstrate compliance with the IAEA Regulations. Analysis was made of the different design and test requirements and test procedures used and their usefulness was evaluated. Special attention was paid to the assessment criteria for Type A packaging (contents and radiation leakage tests, especially those proposed by the International Organization for Standardization) and proposals were made for the formulation of the contents and radiation leakage criteria. A list of publications pertaining to the design and testing of packagings for radioactive material is provided. (auth)

51809 TESTING TYPE A PACKAGINGS. Dixon, F. E.; Cohen, L. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 93-106 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

Methods are described for carrying out the tests for Type A packaging given in Annex IV, I-1 to I-3.3 of IAEA Safety Series No. 6 (1967) together with those tests which are necessary to ensure that the packaging meets the various requirements of Annex II and other sections of the Regulations. Attention is drawn to the various items used in packaging and to the importance of correct specifications of the items. Some examples are given of the severe treatment to which well designed Type A packages may be subjected without failing. A check list of required design features which need testing is given. Most of the apparatus described is inexpensive and represents a practical approach to this problem. (auth)

51810 RESULTS AND EXPERIENCE OBTAINED IN THE TESTING OF TYPE A PACKAGING USED IN HUNGARY. Repas, L.; Golder, F. (Inst. of Isotopes, Budapest). pp 107-17 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

Models of Type A packaging used in Hungary are described. The design of various types of equipment used for testing packaging in accordance with IAEA rules is discussed. Results of tests carried out for the purpose of confirming the model data are presented. A number of tests simulating accidents under transport conditions have also been carried out. (auth)

51811 STANDARDIZATION OF PACKAGING FOR THE TRANSPORT OF RADIOACTIVE MATERIALS AND TESTING OF EXPERIMENTAL SAMPLES UNDER SIMULATED ACCIDENT CONDITIONS. Lukishov, G. I.; Shcherbenok, G. U.; Leonteva, L. V. (State All-Union Research Inst., Moscow). pp 119-28 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The basic principles involved in standardizing the parameters of packaging for the transport of radioactive materials as well as the design solutions that have been adopted for containers and external packagings and the technical and economic justifications for those solutions are considered. The procedures used in testing the packages are described, as are the test stands themselves and the test conditions. The results of factory tests carried out on Type A and B packages to determine mechanical strength, shielding properties and leak-tightness under simulated accident conditions are given. In view of the fact that the Soviet programme on standardization of transport packaging involves a great deal of experimental and design work, and that such work has been performed in most member countries of the IAEA, the information presented will be useful and should help in the preparation of international standards for packaging. (auth)

51812 EXPERIENCE WITH PACKAGING FOR THE TRANSPORT OF RADIOACTIVE MATERIALS. Prasad, A. N.; Seetharamiah, P.; Kulkarni, M. D.; Balu, K. (Bhabha Atomic Research Centre, Trombay, India). pp 129-40 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The Bhabha Atomic Research Center in India operates a fuel reprocessing plant, produces a wide variety of radioisotopes, including ^{60}Co, and has a well organized waste treatment and disposal system. A plant for reprocessing power reactor fuels is currently under construction. The experience acquired in packaging radioactive materials such as irradiated fuel, radioisotopes and highly active waste, and the test requirements adopted for such packages are described. (auth)

51813 OVERVIEW OF PACKAGE TESTING IN THE UNITED STATES OF AMERICA. Sisler, J. A. (Atomic Energy Commission, Washington, D. C.). pp 141-60 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

Package testing in the United States of America differs considerably from that in Europe. These differences in approach are discussed, particularly with respect to model testing and calculative schemes. Testing of shipping containers for radioactive material is reviewed from the standpoint of evolution, present status and future trends. The discussion of evolution of container testing in the United States includes the regulatory history, government and private industries' motivation for conducting tests, the relationship between government and the nuclear industry, and a comparison of model testing versus full-scale testing. A listing of all facilities known to have had or which currently have testing programs under way is included with brief descriptions of the results. In conclusion, predictions on future trends are presented. (auth)

51814 CARRYING OUT MECHANICAL AND THERMAL TESTS. Labrousse, M.; Remy, J. (CEN, Fontenay-aux-Roses, France). pp 161-75 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971). (In French).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The IAEA regulations for the safe transport of radioactive materials define methods for mechanical and thermal testing to establish whether packages conform with the provisions of Section C-2 concerning Type A and Type B packaging. France, like other States Members of the Agency, is therefore now equipped with installations which have enabled many packaging tests to be undertaken. It therefore seemed worth while to make known the experience gained by the CEA in this field. Three aspects of this testing program are described: the testing station installations and the checking and measuring devices with which the station is equipped (leak-tightness check, temperature and acceleration measurements etc.); the statistical data relating to tests already undertaken and the main difficulties encountered in carrying out the various tests; and the studies undertaken by the CEA in the field of scale-model tests. (auth)

51815 FURNACE AND DROP TESTING OF TYPE B PACKAGINGS. PRACTICAL PROCEDURES AND WEIGHT LIMITATIONS. Dixon, F. E.; Davies, A. J.; Cohen, L. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 177-84 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

Equipment and methods of carrying out the furnace tests and the mechanical test given in Annex IV, I-4.3.3 and Annex IV, I-4.2., respectively, of the Regulations for the Safe Transport of Radioactive Materials, 1967 Edition, IAEA Safety Series No. 6 are described. The examples show the uses to which relatively commonplace equipment may be put in performing these tests. Suggested limits of weight and size are given for the methods proposed. (auth)

51816 CRITERIA FOR THE ASSESSMENT OF LEAKTIGHTNESS AND SHIELDING PROPERTIES IN PACKAGING FOR THE TRANSPORT OF RADIOACTIVE MATERIALS. Lukishov, G. I.; Shcheglov, K. V.; Shcherbenok, G. V.; Smirnova, N. V.; Arbaeva, E. S. (State All-Union Research Inst., Moscow). pp 185-92 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

Since the Agency's "Regulations for the Safe Transport of Radioactive Materials" do not contain recommendations on criteria for assessing the leaktightness and shielding properties of packaging, methods of testing packages have been developed in the USSR on the basis of definite quantitative values for permissible leakage of radioactive materials, quality of shielding and durability of the properties of the packaging. The values adopted for these criteria need further refinement, however, and should be analyzed by all countries so that a common, unified set of recommendations on criteria for leaktightness and shielding properties of packaging can be worked out and applied on an international scale. (auth)

51817 TESTS FOR INTEGRITY OF CONTAINMENT AND SHIELDING AND CRITERIA FOR REJECTION OF PACKAGING. Neider, R. (Bundesanstalt fuer Materialpruefung, Berlin). pp 193-216 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The tests prescribed in the IAEA Regulations make severe demands on the shielding and containment of the different types of packaging for radioactive materials. To ascertain that these requirements are met, "tests on tests" are necessary. These comprise the radiation leakage and contents leakage tests. A contents leakage test is not described in the Regulations and, hence, criteria for rejection of packaging because of bad containment are missing. The following tests are described: a contents and radiation leakage test proposed by ISO/TO 85/SC4; the bubble test; the pressure rise test; He leak tests; and the back pressurizing test. The applicability and sensitivity of these tests are compared, and different criteria for rejection are discussed. It is proposed that maximum permissible leak rates be defined in quantities which are useful for engineering methods of leak testing and which correspond to the activity leak rates given in the Third Revised Draft of the IAEA Regulations. (auth)

51818 TESTS FOR INTEGRITY OF CONTAINMENT OF LARGE RADIOACTIVE-MATERIAL PACKAGES. Messenger, W. De L. M. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 217-26 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

Complete immersion tests designed for the leak testing of small packages are not suitable for large packages such as irradiated-fuel flasks. The arrangement for the closure joint of a large package, used in the UK, is examined and shown to enable rapid quantitative gas leakage tests of a conservative nature to be conducted, free from thermal errors and without breaching containment. A procedure based on Poiseuille's formula is described by which the results may be used to predict gas and liquid leak rates under both normal and accident conditions and to demonstrate that activity leak rates will be within the regulatory limits. (auth)

51819 RADIOMETRIC METHOD FOR PRACTICAL RADIATION LEAKAGE TESTING OF PACKAGES FOR THE TRANSPORT OF RADIOACTIVE MATERIALS. Wiesner, W. (Polon Nuclear Equipment Establishment, Poznan, Poland). pp 227-36 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

A radiometric method for determining the radiation leakage from packages for the transport of radioactive materials is described. This method was studied with the object of reducing measuring time. Experiments on the practical application of this type of monitoring support the conclusion that saving time in radiation leakage testing during serial package production is a most important consideration. The following questions were considered: the effect of the integrator time constant and the speed of rotation of the tested package on the accuracy of the curves obtained; the size and shape of the collimator and the extent of the damage; the changes in the angle of inclination of the measuring probe; the activity of the source used for measuring; and the counting rate and the time constant. The integrator time constant has a considerable effect on reduction of the time required for one revolution of the package during testing and also on the accuracy of the curves. The size of the radiation source and the counting rate are also related to this question, since too large a radiation source is unsuitable for safety reasons. Collimators of rectangular and circular cross-section were studied. The size of the collimator and its distance from the target surface have a considerable effect on the number of changes in the angle of the probe device and, consequently, on the time required to complete the testing operation. Tests were carried out with a unit comprising a revolving table with regulated speed of rotation, a scintillation probe and collimator fixed on a movable arm, and a linear integrator with a recording device. The question of distance of the measuring probe from the package under test was also investigated. Practical suggestions are made on container evaluation criteria and the establishment of comparative standards. (auth)

51820 METHODS AND RESULTS OF TESTING PACKAGING OF THE UKT-I-V AND UKT-II-V TYPES. Gorshhov, N.; Tupitsyna, N. (State Committee on Atomic Energy, Moscow). pp 243-53 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The sequence and methods of testing samples taken from a

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batch of manufactured packagings of the UKT-I-V and UKT-II-V types are described. The tests were carried out on samples made in 1969. The test procedure is in accordance with Appendix IV of the Regulations for the Transport of Radioactive Materials adopted by the Member States of CMEA (Council for Mutual Economic Assistance). The sequence of the tests was: leak-tightness; mechanical strength (drop test with impact); thermal stability; leak-tightness. The procedure for thermal stability tests is described, with illustrations of the dynamics and degree of heating applied to all basic components of the packaging. The nature of the resulting damage and its effect on the shielding properties are discussed. The tests confirm the reliability of the package design developed in the USSR for gamma sources representing hundreds and even thousands of g-eq of radium. (auth)

51821 ADVISABILITY OF SEPARATING FUNCTIONS IN THE ORGANIZATION OF PACKAGING. Vertut, J. (CEN, Saclay, France); Bernard, H. pp 255-67 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971). (In French).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The various functions which packaging should fulfil are: containment, shielding, impact resistance, fire resistance and leak-proof transfer from high-activity installation to packaging section. Examples of type B packaging technology are used to show the advantages afforded by separating these functions into distinct mechanical components. First, the operational advantages afforded when high activity installations are put into service, in particular the reduction or even the total elimination of contamination of shielding devices are emphasized. This yields economics in decontamination and quicker turnover in the packaging area. Second, the advantages provided by such an approach are shown when demonstrating, with a minimum number of tests, the strength of packages in conformity with regulations. These packages include standardized leak-proof internal containers which can be readily connected to the confinement area of high activity installations, using the double door leak-proof transfer. (auth)

51822 EFFECT OF HYPOTHETICAL TRANSPORT ACCIDENT CONDITIONS ON THE QUANTITY OF FISSILE MATERIAL ALLOWED PER PACKAGE. Wolfe, R. A. (Mound Lab., Miamisburg, Ohio). pp 269-89 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The criteria for hypothetical accident conditions, when not applied with extreme care, can result in unnecessarily restrictive limitations on the packaging and shipment of fissile material. The use of the "Density Analog" calculational technique, the problem areas encountered, and the conservatism resulting when proper assumptions are not applied to the interpretation of the hypothetical transport accident conditions are described. The effect of neutron absorbers, moderators, reflectors and various accident conditions (impact, fire, immersion with the leakage of water into the package) on the nuclear safety of packages containing plutonium-238 is discussed. Mound Laboratory has become the world's leading manufacturer of radioisotopically powered heat sources containing large quantities of the highly enriched plutonium-238 isotope and, consequently, has shipped large quantities of this isotope. Only within the past few years has the quantity of plutonium-238 become abundant enough to be considered a potential hazard to the public through its shipment. Because of the unique nuclear characteristics of plutonium-238 (i.e., specific activity of 17.17 Ci/g, spontaneous fission neutron yield of 3×10^3 n/sg, emission of a 5.5-MeV alpha particle, a thermal output of 0.57 W/g, and a calculated minimum critical mass of approximately 7.2 kg), many differently constructed shipping containers have had to be designed. The nuclear characteristics of plutonium-238 are significantly different from other fissile isotopes so that a separate set of packaging and testing criteria is necessary for shipments involving large quantities of this isotope. The transport index and fissile class for a package of fissile material are determined in relationship to the hypothetical accident conditions as specified in the USAEC Manual, Chapter 0529 "Safety Standards for the Packaging of Radioactive and Fissile Materials," the US DOT Hazardous Materials Regulations (49 CFR, Parts 170-190), and the IAEA Safety Series No. 6, "Regulations for the Safe Transport of Radioactive Materials." Calculational results are presented that describe the effect of accident conditions in relation to the nuclear safety of several shipping containers, e.g., the DOT Special Permit No. 6000 Package for large quantities of fissile waste material. (auth)

51823 DESIGN AND PERFORMANCE EVALUATION OF A LARGE FISSILE SOURCE CONTAINER. McDonald, E. P. (Mound Lab., Miamisburg, Ohio). pp 301-13 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The transportation of radioisotopic heat sources with high thermal outputs has presented a number of problems in the past. A container has been designed, approved for use and constructed, and its use has eliminated these problems while complying with all the regulatory requirements for large fissile source shipments. The container was proven to provide the necessary protection without destructive tests of any type being applied. The container, its approved contents, and the methods of its evaluation are described. The container, designated the Universal Source Container, is designed to transport a variety of radioactive thermal generators (heat sources) containing up to 2250 g of plutonium-238. Its capability to transport heat sources with different configurations is another unique feature. A description of the nondestructive testing methods and the basic mathematical evaluation technique is presented to highlight the procedures followed in affecting a satisfactory performance evaluation. The tests described include one for thermal capacity and another to determine the shock and vibrational input to the container and contents resulting from a 2000-mile trip by truck. The performance evaluation was made in the light of both the applicable transportation regulations and the quality assurance requirements of components for use on extra-terrestrial voyages. (auth)

51824 DESIGN OF LOW-COST FIRE SHIELDS FOR SMALL AND LARGE RADIOISOTOPE SHIPPING CONTAINERS. Harrod, R. A.; de Lind Van Wijngaarden, J. D. W. (Atomic Energy of Canada Ltd., Ottawa). pp 315-37 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

Small and large shipping containers have been equipped with fire shields designed to withstand a 1475°F fire for 30 minutes as defined in the IAEA Regulations for the Safe Transport of Radioactive Materials. Here, "small" containers refer to those containers in which heat generation from the radioactive source does not result in undesirable high temperatures in the package. "Large" containers refer to those in which the heat dissipation must be taken into consideration in both the design of the container and its fire shielding. Since small containers generally have low heat capacities, survival in fire depends primarily on the insulating capability of the fire shield. At AECL, containers up to 400 lb are shipped in standard sized drums with wood as an insulating material. Containers ranging from 400 lb to 4500 lb are shipped in sheet-steel enclosed wooden boxes. Provided the wood is adequately shielded from the atmosphere, almost any species of wood is acceptable for fire protection. Double-shelled containers in which the entire surface is enclosed with an insulating material are also used at AECL. The heat capacity of the large containers of 6500 lb becomes significant and can be protected with a partial fire shield. With the inherent heat capacity of the container, the fire shield is designed so that no lead melting occurs during the fire test. The vulnerable areas, such as the container's plug and angled intersections, are insulated. To keep heat dissipation under normal conditions at a maximum, insulation is minimized through the use of a partial fire shield. A large protected container was drop and fire tested at N.R.C. Canada. A mobile crane was used to lift the container to a height of 30 feet and then drop it on bedrock. The container was then fire tested, without a radioactive or simulated heat source, in a propane-gas-fired furnace. To correlate the test results to IAEA requirements, allowance was made for an internal heat source and the ambient air temperature was adjusted. In calculation, the energy balance method and the Schmidt plot were used. (auth)

51825 PLANNING FOR SAFETY IN PACKAGING AND TRANSPORTING URANIUM HEXAFLUORIDE. Barton, J. C. (Union Carbide Corp., Oak Ridge, Tenn.); Freeman, A. T. pp 339-54 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The next two decades will bring tremendous increases in the use of nuclear fuel for power generation. These changes will be accompanied by unprecedented and ever increasing expansion in packaging and transporting uranium hexafluoride from UF_6 manufacturing plants to the isotope enrichment facilities and thence to the fuel fabricators. The US Atomic Energy Commission and its prime contractors for the United States gaseous diffusion complex have had extensive experience in handling, packaging, transporting, sampling and analyzing this radioactive, corrosive, and fissile material. They have the responsibility of sharing this information with the many new companies entering the nuclear fuel cycle. Because of the value of uranium hexafluoride, releases during packaging and transportation can result in high monetary losses. For example, a 14-ton cylinder of natural UF$_6$ is worth approximately $200,000. A single 2.5-ton cylinder of material enriched to 5% ^{235}U is valued at approximately $700,000 and several such cylinders are often transported on a single vehicle. Additionally, criticality and/or health-physics problems of even more serious proportions could result from a wreck in transit. It is therefore of the highest importance that rigid standards for packaging and transporting UF$_6$ be developed and closely followed. Recommendations supported by technical data are presented for the design and handling of shipping cylinders. Consideration is given to design pressures, wall thicknesses, methods of installing valves, maximum operating temperature, volume certification, use of protective valve covers, and cylinder fill limits. Inspection and test methods which are employed to determine the acceptability of new cylinders and to evaluate periodically cylinders in service are described. Also, since plausible concentrations of impurity gases can lead to the development of intolerable pressures in cylinders during liquefaction, the dangers involved and means of handling such cylinders are discussed. For criticality control, any cylinder containing material enriched above certain levels must be enclosed in an approved protective package which has passed severe drop and fire tests. An extensive development program has been conducted, resulting in a unique material which is used in protective packages for several types of UF$_6$ shipping cylinders. (auth)

51826 DESIGN CONSIDERATIONS FOR HIGH-VOLUME IAEA TYPE B PROTECTIVE OVERPACK SHIPPING CONTAINERS IN USE WITH CURRENT TRANSPORTATION SYSTEMS. Gablin, K. (Protective Packaging, Inc., Tacoma, Wash.). pp 355-64 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The design and testing of two protective overpack systems are discussed. The first, the Paper Tiger, is a protective overpack for a USDOT 17H 55-gallon drum. The second container with its overpack is much larger, and because of its size of 8 ft × 8 ft × 20 ft is called the Super Tiger. This overpack is in the configuration of a standard international cargo container commonly used in maritime and land transportation, both on trucks and rail cars. The testing of the Super Tiger was probably the most massive performance test done to date on any Type B overpack. Logical methods for making a complete system requiring packaging, material handling, and transportation are reviewed. (auth)

51827 RADIATION HEAT TRANSFER INTO FINNED SURFACES AND ITS RELEVANCE TO IAEA REQUIREMENTS FOR THERMAL BEHAVIOUR OF TRANSPORT CONTAINERS UNDER ACCIDENTAL FIRE CONDITIONS. Brook, A. J. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 365-77 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

Large containers used for transporting radioactive materials are frequently provided with cooling fins on their outer surfaces to assist in heat dissipation, which is largely convective under normal conditions. Under accidental fire conditions, when the heat input is largely radiative in nature, the presence of these fins may result in a significant increase or decrease of the heat input into the flask. A description is given of the details of a model upon which a computer study was based, by which the temperature and thermal-flux distributions within the finned area are evaluated, and the results of an investigation into the effects of varying the more important parameters, such as fin thermal conductivity and geometric arrangement are presented. It is shown that, by suitable choice of these parameters, significant reduction of the thermal flux into the finned body can be achieved without adversely affecting normal convective heat loss. A comparison is made between the results of these theoretical calculations and the results of practical experiments with open-air fires and closed furnaces. (auth)

51828 HEAT REMOVAL TEST ON A SPENT-FUEL SHIPPING CASK. Aoki, S. (Tokyo Inst., of Tech.); Sawai, S.; Nakata, S.; (and others). pp 379-95 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

A model cask was designed and fabricated to the same scale as the actual spent fuel shipping cask and experiments were performed, with varying decay heat generation rate, under conditions simulating both normal transport and the loss of coolant due to an accident in transport. Design data for the cask and the simulated fuel assembly (installed in the cask) are as follows: cask—inner diameter = 500 mm; inner length = 1200 mm; shield thickness = 190 mm; design pressure = 7 kg cm^2; number of simulated fuel assemblies within the cask = 4. Simulated fuel assembly—number of electric heater elements = 100 (containing four dummy rods); outer diameter of electric heater element = 10 mm. The experimental conditions were: normal transport conditions with coolant; accident conditions with half the coolant, without coolant, and with gradual coolant loss (initially full). The main experimental results are given below: in accident conditions, the maximum temperature of the cask and the simulated fuel assemblies with half the coolant is considerably lower than with no coolant; an example of the temperature change of the cask and the fuel assemblies was obtained when coolant is gradually lost through the damaged part of the cask bottom; and the heat transfer coefficient at the outer surface of the finned cask is greater than that of a finless cylinder. (auth)

51829 THERMAL ASPECTS OF THE MARINE TRANSPORT OF RADIOACTIVE MATERIALS. Brook, A. J. (United Kingdom Atomic Energy Authority, Risley, Eng.); Dixon, F. E. pp 397-409 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

An outline is presented of the theoretical and experimental background of a number of recommendations relating to the stowage with other cargo of packages containing radioactive materials which are producing significant amounts of heat. Uncertainties in earlier theoretical proposals have led to subsequent experimental work, which has thrown light on the validity of these early assumptions under practical conditions. It has consequently been possible to establish a criterion to determine the conditions under which no special stowage precautions need to be taken, and to make recommendations relating to stowage precautions when this criterion cannot be met. (auth)

51830 FUNCTION OF A QUALITY ASSURANCE PROGRAM IN THE DESIGN AND FABRICATION OF A RADIOACTIVE-MATERIAL SHIPPING PACKAGE. Shappert, L. B. (Oak Ridge National Lab., Tenn.). pp 411-21 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The need for strong, viable standards in the nuclear industry has become apparent in recent years. The availability of workable standards is expected to result in reduced costs, increased reliability, and enhanced safety. In recent years, the USAEC has funded a program to develop such standards, which have included the development of quality assurance requirements. These requirements are applicable to all phases of a project, including the planning, design, fabrication, and operation of shipping container for transporting radioactive materials. While past operational experience involving radioactive-material shipping containers has been quite satisfactory and performance standards to which the packages were designed have been adequate, fabrication standards were developed on an individual basis to meet the immediate need; little thought was given to documenting what was done, what inspections were made, and what difficulties were encountered. To provide assurance that a shipping container, or cask, of known high quality is developed, the procedures involved in its design, fabrication, operation, and maintenance must be integrated and documented. This can be accomplished through the use of a quality assurance program plan, the elements of which are described. However, to produce an effective program plan, basic equipment parts and services must be evaluated with respect to their importance. This evaluation leads directly to the establishment of levels of quality, which are discussed in detail. Elements of the program plan are then applied to the specific problem of designing and fabricating a 25-ton transuranium-isotope shipping container. (auth)

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51831 QUALITY CONTROL. IMPLEMENTATION OF SOME INSPECTION, TEST, AND CERTIFICATION REQUIREMENTS OF SECTIONS C-6 AND C-7 OF THE IAEA REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS. Messenger, W. De L. M. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 423-32 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

Quality control of actual packaging and packages (as opposed to testing designs and having them approved by competent authorities) is discussed. Six distinct requirements of the present regulations are examined and include: containment vessel material specifications and tests before manufacture; inspection of packaging by competent authorities during manufacture; submission of inspection certificates by consignors to competent authorities after manufacture; consignors' test of packaging before first use, covering containment, shielding, heat transfer and nuclear safety; submission of inspection certificates by consignors to competent authorities in support of large radioactive source shipment approval; and consignors' tests of large radioactive source packaging before each shipment. Maintenance in service (a projected requirement) is also discussed. Certain practical difficulties are brought to light and give rise to a number of questions, to some of which practical solutions are proposed. Others require further study. (auth)

51832 METHODS OF DEMONSTRATING THE ABILITY OF TYPE B PACKAGING TO PASS THE THERMAL TEST. Teague, H. J. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 455-65 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The test requirement should lead to a realistic degree of fire protection but not embrace the worst conceivable fire conditions: it is based on judgement that depends on theoretical interpretation of limited experimental data. Its application should encourage inventiveness, and the use of the widest possible range of techniques. Methods are reviewed against this background, with special reference to their adequacy; to reasons for preferring or avoiding certain methods; to identification of areas requiring substantial investigation; and to success of the test in furthering the above aims. It is concluded that, so far, the available methods have proved adequate; that theoretical assessment is of paramount importance and model testing of very restricted value; and that a systematic optimization study of the potential of new "thermal switch" devices would be valuable. Whether or not the test specification is too lenient, too severe, or too constricting for designers is a matter for the collective judgement and experience of those engaged in this type of work. (auth)

51833 STUDYING THE THERMAL PERFORMANCE OF CONTAINERS FOR TRANSPORTING RADIOACTIVE MATERIALS. A REVIEW OF TECHNIQUES IN THE UNITED KINGDOM. Brook, A. J. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 467-77 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

Considerable experience has been gained over recent years in the UKAEA with the various methods that may be used to assess the thermal performance of transport containers. The use that has been made of computer programs both to study the behavior of complete flasks under a range of transient conditions and to investigate particular phenomena in more detail, such as the temperature distributions in the corners and edges of flasks, and the distribution of temperature and thermal fluxes in finned surfaces are reviewed. The use and limitations of simpler analytical models are discussed, and guidance is given on the degree of flask complexity which can readily and confidently be handled by standard computer programs. A brief outline is given of basic experimental work which has been performed, and the need for close cooperation between theoreticians and experimentalists is emphasized; the results of some examples of such co-operation, e.g., in transport of radioactive materials in ships and in the development of wooden overcoats for fire protection are instanced. Looking to the future, the changes in assessment techniques which will be made necessary by the likely continuation of present trends in container design are considered. (auth)

51834 METHODS OF DETERMINING COMPLIANCE OF TYPE B PACKAGES WITH THE THERMAL AND MECHANICAL REGULATORY REQUIREMENTS. Shappert, L. B.; Evans, J. H.; Stoddart, W. C. (Oak Ridge National Lab., Tenn.). pp 487-508 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The IAEA Regulations require radioactive-material shipping packages to meet certain performance requirements. The designer must determine what methods are available and applicable to his package design. Generally, the most difficult conditions to meet are those imposed by the accident requirements, namely, the 9-m impact and the 30-min fire. Impact data have been correlated so that, in at least some cases, damage may be predicted empirically. In the absence of such information, scale models may be dropped, and the gross damage to the prototype may be predicted from the damage to the model. Recent tests, made with all-steel cask models, extended the knowledge of impact behavior and also provided deceleration information, which is important in estimating damage to the cask contents. The deceleration data were obtained electronically and processed by a computer code to obtain both velocity and displacement as a function of time during the impact event. Thermal analyses are generally amenable to calculative methods, and computer codes can be used advantageously to determine cask response to the solar heat load and the hypothetical 30-min fire. A comparison of the response of both a uranium-shielded cask and a steel-shielded cask to the 30-min and 4-h fires indicated that the steel cask is capable of maintaining significantly lower temperatures in the extended fire. Thermal stresses in massive cask walls have been found to be significant, and a computer program that is available to study them is discussed. (auth)

51835 MATHEMATICAL MODEL FOR PREDICTION OF MAXIMUM DAMAGE TO SHIELDED SHIPPING CONTAINERS. Donham, B. J. (Los Alamos Scientific Lab., N. Mex.). pp 509-23 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The damage to a shipping container for radioactive materials resulting from a 30-foot (9.14-m) free fall cannot be totally predicted by any known means. Even when the drop is performed experimentally there are too many variables for good uniformity of results. The concept of an "essentially unyielding surface" is not the least troublesome of these variables, and the requirement that the container be dropped so as to cause maximum damage is not easy to satisfy without using a lot of human judgement. By selecting one drop configuration, a method has been devised by which the deformation of a lead cylinder may be mathematically predicted. A 9.14-m free fall of a lead cylinder which lands on an unyielding surface with its longitudinal axis vertical will dissipate more than 95% of its total kinetic energy through plastic flow of the lead. The method was developed through a numerical analysis technique by treating the cylinder as a number of discrete elements with dynamic properties which were varied to simulate the changing geometry of the cylinder as it deformed. Experimental proof of the calculation was obtained by dropping lead cylinders from a prescribed height and comparing the results with those predicted by the calculation. With the results from the numerical analysis being used to establish the behavior patterns of the cylinders, a simplified mathematical model was established that could be applied without the use of electronic computers. This simplified approach was then applied to a steel-jacketed radioactive waste shipping container which was subsequently subjected to a 9.14-m drop. Theoretical and experimental results were in sufficiently close agreement for the method to be considered valid for establishing upper limits of expected damage. (auth)

51836 TESTING A SHOCK ABSORBER OF UNIQUE DESIGN TO DEMONSTRATE THAT A TYPE B PACKAGING WOULD PASS THE FREE-DROP TEST. Rollins, J. D. (Nuclear Fuel Services, Inc., Rockville, Md.); Evans, J. H. pp 525-35 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

An extensive series of drop tests was performed at the Oak Ridge National Laboratory on both isolated and package-attached shock absorbers of a newly-conceived tube-in-tube design. The experimental methods used in the drop-test series are described, and, interpretation is presented of the results based on an experimental observation as well as analytical corrections made available through computer reduction of data instrumentally recorded during the tests. The primary objective of these experiments was to demonstrate the ability of Type B packaging to pass the free-drop test successfully through the use of an ancillary shock absorption device which is simple and inexpensive to fabricate, and yet effectively absorbs energy while adding insignificantly to the overall volume and weight of the packaging system. A secondary objective was to evaluate the effects of various shock-absorber design parameters such as tube-wall thickness, tube material, tube configuration and the number of tubes on energy-absorption capability. Tests were conducted at the ORNL Drop Tower Test Facility which provides facilities for weight-controlled impact studies as well as experimental 30-ft free drops of packages weighing up to about 3000 lb onto an essentially unyielding surface. In the first series of tests, impact weights ranging up to 600 lb were free dropped from a height of 30 ft onto isolated shock-absorber specimens of various sizes, compositions and designs. Energy absorption data were recorded by means of a load cell and oscilloscope-polaroid camera assembly. From these recorded data selected types of shock absorbers were designed, fabricated and attached to scale-model packages for a second series of free-drop tests. By means of the aforementioned instrumentation, maximum impact force was recorded for a $^{1}/_{8}$-scale model package with and without shock absorbers of various sizes. Design data for determining the shock absorber size required to protect Type B packaging during the free-drop test as a function of package size and weight were generated by means of a structural analysis computer program. This program utilized input data in the form of force-time relationships recorded during the experiments and performed a double numerical integration along with associated functions to generate output data which related energy absorption to shock absorber deformation. (auth)

51837 TESTS ON A SPENT-FUEL SHIPPING CASK IN JAPAN. Aoki, S. (Tokyo Inst. of Tech.). pp 539-47 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

To obtain the necessary design data for shipping casks for transporting large amounts of spent fuel from nuclear power stations in the near future, several experimental studies under accident conditions were carried out in Japan. Most of these experiments were performed by the JSME (Japan Society of Mechanical Engineers) and supported by the Research Fund for Peaceful Uses of Atomic Energy of the Agency of Science and Technology. The completed experiments and those currently in progress included: experimental study on heat removal from a spent-fuel shipping cask (1967); experimental study on the drop impact of a spent-fuel shipping cask (I) (1968); experimental study on the drop impact of a spent-fuel shipping cask (II) (1969); and experimental study on the drop impact of a spent-fuel shipping cask (III) (1970). Only drop impact tests (II) and (III) are described. In drop impact test (II), an 80-ton spent-fuel shipping cask was taken as the prototype for light-water nuclear reactors and four kinds of scale models were manufactured weighing 10 ton ($^{1}/_{2}$ scale), 5 ton ($^{1}/_{2.5}$ scale), 1.25 ton ($^{1}/_{4}$ scale) and 0.15 ton ($^{1}/_{8}$ scale), respectively. In the free drop from 9 m on the acceleration and deformation were measured and the motion of the models was recorded and analyzed. On the basis of these results, the scale effect was investigated. In drop impact test (III), the corner drop was carried out with the above-mentioned scale models, and the effects of several kinds of shock absorber on the quarter-scale model (1.25 ton) are currently being investigated. (auth)

51838 DROP-IMPACT TEST ON A SPENT-FUEL SHIPPING CASK. Shimamura, S. (Japan Society of Mechanical Engineers, Tokyo); Kanae, Y.; Muramatsu, A.; (and others). pp 549-61 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

The drop-impact test on a spent-fuel shipping cask carried out in Japan in 1968 is described. The drop-test facility, which was designed on the basis of the IAEA Regulations, 1967 Edition, was constructed on the site of the Government Mechanical Laboratory. The specifications of the facility are as follows: maximum test weight of 10 tons; maximum drop height of 9 m; target—a reinforced concrete block of 6 m × 6 m × 2.5 m with a steel plate of 12.5-mm thickness on the upper surface. The prototype cask was a horizontal cylinder weighing 80 tons. One-sixteenth- and one-eighth-scale models of the prototype cask were manufactured and tested. In this project, 20-kg lead spheres and cylinders were also tested with the above-mentioned test facility to determine the mechanical behavior of lead at drop impact. In these tests the decelerations at the moment of drop impact were measured with an accelerometer mounted on the top surface of the models. Deformations in these models due to the drop impact were also observed. In addition, high-speed cinematography was used to determine the motion of the models during the tests. (auth)

51839 APPLICATION OF IMPACT TESTING TO IRRADIATED FUEL FLASKS. Williamson, S. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 563-85 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

A brief examination is made of a problem encountered in assessing the design of an irradiated fuel flask. (Steel flasks only are discussed but certain aspects are common to all types of flasks, including lead.) It indicates that, although calculations might be performed to show that the flask structure remained sound after the IAEA 9-m drop test, assumptions would have to be made which would be difficult to justify. An examination is made of the results of drop tests of small steel specimens which indicates that damage or deformation of one specimen can be scaled directly to another similarly shaped specimen of different size. This information is used to justify tests with scale-model flasks. A review of $^{1}/_{16}$- and $^{1}/_{4}$-scale model tests is given, which shows the advisability of using a $^{1}/_{16}$-scale model in preliminary tests. These small-scale tests can be quickly carried out and will give advance information to the designer regarding the correctness of his design. Subsequent tests carried out on $^{1}/_{4}$-scale models, incorporating any rectification found necessary from the $^{1}/_{16}$-scale tests, may be used to prove a design to the satisfaction of competent authorities. It is also indicated that leakage tests carried out on the $^{1}/_{4}$-scale model flasks can be used to show that the full-scale design complies with the limits of activity release permitted by the IAEA Regulations. (auth)

51840 DESTRUCTIVE TESTS RELATED TO DEVELOPMENT OF LMFBR FUEL SHIPPING CASKS. Irvine, A. R.; Shappert, L. B.; Evans, J. H.; Davis, F. C. (Oak Ridge National Lab., Tenn.). pp 587-602 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

Models of steel-shielded cask structures, all-metal cask closures, and impact energy absorbers were destructively tested in one phase of an LMFBR fuel shipping cask development program. Various scale models of a large steel cask were impact tested and, with the exception of a very small ($^{1}/_{37.5}$-scale) unit, were found to behave in a generally proportional manner. A 30-ft free-fall impact test with unprotected steel specimens produced only external deformation; there was no evidence of any change in internal volume or of cracks or fissures. Scale models of an all-metal seal were mounted in a $^{1}/_{6}$-scale steel cask that was subjected to a 30-ft free-fall impact test in which deceleration forces were as high as 2300 g. The very low initial leak rate was increased only slightly by the test. Fins and a tube-in-tube energy absorber were tested to determine their performance characteristics. Fins must be relatively short and thick to absorb substantial amounts of energy and, when loaded to yield maximum energy absorption, exhibit high peak resistances at the beginning of deformation. The tube-in-tube energy absorber has no preferred direction for loading, can be made in large sizes to produce low decelerations, and has no sharp peaks in its loading curve. (auth)

51841 APPLICATION OF IMPACT TESTING TO LID-FIXING SCREWS OF IRRADIATED FUEL FLASKS. Williamson, S. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 603-19 of Tests on Transport Packaging for Radioactive Materials. Vienna; International Atomic Energy Agency (1971).

From Tests on transport packaging for radioactive materials seminar; Vienna, Austria (8 Feb 1971). See STI/PUB-285; CONF-710210.

Drop tests performed on scale models of irradiated fuel flasks have indicated that scaling comparisons cannot readily be made of the effect of impacts on the lid-fixing screws. A series of impact tests was performed to examine the effect of dynamic tensile loading on single screws of different sizes. A range of screws from the "Excellox" and "Magnox" irradiated fuel flasks was chosen at $^{1}/_{16}$

and 1/4 scale and also, since single screws only were being tested, at full scale. Each screw was set up with a known weight fitted under the head and then tightened to a known torque. The assembly was dropped 9 metres so that the weight stretched the screw shank. Examination of the permanent extension that occurred suggested that, within the limits of the equipment used, the percentage extension of screws at different scales was approximately constant and, therefore, linear scaling can be accepted. (auth)

51842 IMPROVEMENTS TO DEMOUNTABLE CELLS. (to Societ Le Calhene). British Patent 1,223,630. 3 Mar 1971. Priority date 28 Dec 1967, France.

Each wall of a demountable shielded cell suitable for handling radioactive materials is made up of a minimum number of different types of standard demountable and reversible elements of a size designed for reuse and provided with the necessary penetrations for the operating requirements. Each unit is of a size related to the basic square unit, and some of the wall units are provided with corner posts for fastening to the other members. (B.L.M.)

51843 TRANSPORT OF RADIOACTIVE MATERIALS. Crivelli, R. L. (Australian Atomic Energy Commission, Coogee). Aust. Transp.; 13: 17-19(Jan 1970).

Shipping of radioactive materials is considered in three categories: minerals and concentrates; artificial radioisotopes and; high-activity radioisotopes used as radiation sources. The mode of containers for each is described and shipments and travel techniques in Australia are covered on a topical level. (INIS)

51844 SAFEGUARDS INSPECTION: AN ANALYSIS OF DETECTION METHODS AND DIVERSION STRATEGIES. Servais, F.; Goldschmidt, P. (Belgonucleaire, Brussels). Nucl. Technol.; 12: No. 3, 290-7(Nov 1971).

A stochastic model is described that enabled the quantitative assessment of the efficiency of safeguards operations in reprocessing or fabrication plants. The a priori assumption, or "zero-hypothesis" is that there has been no diversion of fissile material, the inspector's task being to invalidate it. To detect diversion, the inspector will resort to three criteria. The first one sets an upper bound M for the total mass uncertainty. When the latter reaches M, the inspector will take a plant-wide inventory. The second criterion enables him to decide whether or not an estimated mass balance is compatible with the agreed model. The third criterion connects the mass uncertainty to the time it lasts; moreover, it settles the number of strategic points within the plant. As an application of the mathematical model developed, systematic cheating strategies are studied. Under the rules assumed, a diverter will achieve maximum total withdrawal at minimum probability of being caught by following a strategy of erratic withdrawal and occasional reinsertion. This renders it necessary for the inspector to assess an upper limit to the positive mass balance, a quite unexpected result. (auth)

51845 CONVEYOR SYSTEM. Mann, Charles Alan (to United Kingdom Atomic Energy Authority). British Patent 1,237,861. 30 Jun 1971. Filed 26 May 1967.

Reference is made to conveyor systems for transporting fragile articles. One of the smoothest ways of conveying such articles is to float them along on a cushion of fluid that can be produced by a sequence of small jets. These jets would, however, be wasteful of pumping power if they were continuously operational whether or not there was an article to be conveyed, and various means have been proposed for sensing the presence of an article and for operating values to close the jets in the absence of an article. The system described comprises an array of valve operated jets located at intervals along the path of the article to be conveyed, the valves being opened successively by contact of the article as it proceeds along the conveyor system. While the article is present above the jet orifice only a restricted flow of fluid passes through the orifice, and when the article passes on, the orifice is closed by an unrestricted flow of fluid closing the valve member. The system has a potential application to the transport of nuclear fuel pins. (UK)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 51819, 52142, and 53729.

General Detectors and Monitors

Refer also to abstracts 51361, 51371, 51390, 51907, 51928, 51975, 52095, 52234, 52269, 53485, and 53710.

51846 (A/CONF.49/P–352) HEALTH PHYSICS INSTRUMENTATION AND SYSTEMS. Muzdeka, S.; Koturovic, A.; Sobajic, M.; (and others) (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). May 1971. 20p. (CONF-710901–119). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Health physics instruments and systems developed at the Boris Kidrich Institute are described. Topics include portable measuring meters and monitors, sample measurements, mobile laboratory for radioprotection, and instrumentation systems and networks. (W.H.K.)

51847 (A/CONF.49/P–507) USE OF SHORT-LIVED RADIONUCLIDES IN HIGH SPATIAL RESOLUTION STUDIES IN NUCLEAR MEDICINE. Mallard, J. R.; Parker, R. P.; Trott, N. G. (Institute of Cancer Research, Sutton (England). Surrey Branch). Jun 1971. 15p. (CONF-710901–296). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A review is given of recent developments in the medical uses of short-lived radionuclides with special reference to those emitting photons of comparatively low energy. When combined with the use of new types of gamma imaging devices, these nuclides permit investigations with spatial resolutions considerably better than those achieved with conventional Anger gamma cameras. Recent developments in instrumentation, including work on image intensifier and semiconductor detector systems are reported. Progress in the field of digital analysis of radioisotope tests and scans and in the understanding of the radionuclide visualisation process is outlined. (auth)

51848 (AD–718110) NEW CHARGED PARTICLE DETECTORS. Final Report, November 1, 1966–January 1, 1970. Belanger, Victor J. (EMR Photoelectric, Princeton, N. J.). 17 Mar 1970. Contract F19628-67-C-0024. 75p. (AFCRL–70–482). NTIS.

The objectives of the program were to perform experimental investigations directed toward the design and fabrication of new charged particle detectors. The particle detectors are to be used in satellite, rocket, and laboratory experiments to study the magnetospheric boundary regions of space and must be capable of detecting particles with energies of 1 keV or less maintaining high counting efficiency. To attain these goals it was necessary to do extensive field plotting of entry dynode structures in order to arrive at a design configuration that would ensure good collection and counting efficiencies, also it was necessary to devise equipment, fixturing, and testing techniques for accurately determining spatially these efficiencies. (auth) (USGRDR)

51849 (AD–871790) RADIATION DETECTION EQUIPMENT. Final Report on Materiel Test Procedure. (Army Test and Evaluation Command, Aberdeen Proving Ground, Md.). 26 May 1970. 13p. (MTP–8–3–171). NTIS.

The Army Service Test Procedure describes test methods and techniques for evaluating the performance and characteristics of nuclear radiation detection equipment, and for determining their suitability for service use by the U. S. Army. The evaluation is related to criteria expressed in applicable Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), Technical Characteristics (TC), or other appropriate design requirements and specifications. (auth)

51850 (CONF-701002–, pp 327-30) DETERMINATION OF THE THERMAL–NEUTRON FLUENCE BY COBALT ACTIVATION MONITORS. Aten, A. H. W. Jr. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

Results of a study to describe the measurement of thermal neutron fluence in reactors by cobalt activation are presented. Recommended nuclear constants are given. Disk-type and wire-type detectors were studied of both pure cobalt and aluminum plus 1% cobalt. Epithermal self shielding correction factors and thermal flux perturbation correction factors are presented. (W.H.K.)

51851 (CONF-701002–, pp 343-54) PRECISE FLUX-MEASUREMENT METHODS AND THEIR INTERCOMPARISON BETWEEN 0.5 AND 15 MeV. Liskien, H. (ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France)).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

A survey of recent Central Bureau for Nuclear Measurements (CBNM) work in the field of precise fast flux measurements is given: known fluxes of 0.5-, 1.0-, and 15-MeV neutrons were produced by the associated particle method. In addition, proton-recoil counting with solid radiator telescopes and Perlow-type telescopes and in proportional counters was performed. Several comparisons at different energies show good agreement. Remeasurements of the differential n-p scattering cross section confirmed center-of-mass isotropy and did not show any fluctuations with energy. (auth)

51852 (CONF-701002–, pp 470-80) ABSOLUTE SOURCE DETERMINATIONS WITH BATH TECHNIQUES. De Volpi, A. (Argonne National Lab., Ill.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

For neutron-source standardization, accuracy of just under 0.5% can be ascribed to the manganese-bath procedure. The justification for this accuracy arises from the experimenters' independent evaluation, from verification of various intermediate calibration stages, and from neutron-source intercomparisons. No other technique can be considered as "absolute" in a justifiable sense for detection of neutrons through the entire energy range of thermal to several million electron volts. As a result, bath techniques are coming into further use for neutron-flux standardization or for calibration of detectors used to measure neutron fluxes. Supplementary experimental work that aids in making corrections for neutron escape and for cavity and source absorption is described, and the various internal discrepancies still existing in the bath method are outlined. The virtues of the vanadium bath are discussed along with a report on operational experience. With on-line continuous-monitoring techniques, the Argonne National Laboratory manganese bath has an efficiency of 1 count per 100 incident neutrons at a background of 20 counts/sec; the vanadium bath has half that efficiency and twice the background. Various applications in neutron and reactor physics are mentioned. (auth)

51853 (CONF-701002–, pp 481-7) VARIATION IN PROMPT PULSE EFFICIENCY FOR TWO LIQUID SCINTILLATOR TANKS USED IN $\bar{\nu}$ MEASUREMENTS AT FOA, STOCKHOLM, SWEDEN. Conde, H.; Hansen, J.; Widen, L. (Forsvarets Forskningsanstalt, Stockholm (Sweden)).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The variation in prompt pulse efficiency vs. the number of fission neutrons has been measured for two different liquid scintillator tanks used in $\bar{\nu}$ measurements at the Research Institute of National Defense (FOA), Stockholm. The results have been used to calculate a correction to the absolute ν value of ^{252}Cf measured by Asplund–Nilsson, Condé, and Starfelt. A correction of 0.6% was obtained. The corrected prompt $\bar{\nu}$ value for the spontaneous fission ^{252}Cf is 3.776 ± 0.034. (auth)

51854 (FEI–212) STUDY OF SENSITIVITY VARIATION OF NEUTRON COUNTERS IN VARIABLE GAMMA-FIELDS. Charychanskii, V. V.; Bogatyrev, V. K.; Frolov, V. V.; Korolev, V. I.; Bondarenko, V. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1970. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

A study is made of the sensitivity variation of neutron counters in intense gamma fields. The effect of statistical addition of the neutron and gamma pulses on the sensitivity of the counters to neutrons is investigated in detail. The problem of the possibility of stabilizing the sensitivity of the counters in a variable gamma field is considered. (JPRS)

51855 (JINR–P13–5838) CHARGE MULTIPLICATION IN THE LIQUID FILLED FILAMENT COUNTER. Pisarev, A. F. (Joint

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Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Jun 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The conditions are considered under which singular discharge points appear in the filament particle counters filled with liquid. It is shown that microroughness and microbubbles on the filament affect greatly the appearance of the local discharges. To stabilize the coefficient of the electron multiplication it is suggested to use in the counters a filament of "optimum" diameter, covered with a thin layer of dielectric of weak conductivity. It is advisable to use in the counters as working substance multiatomic liquids and mixtures with a monatomic liquid. The process of the electron multiplication in the counters is analyzed for a new method of feeding—by bipole momenta and by high-frequency field. Common ratios, describing the operation of these counters, are established. (auth)

51856 (LBL-9) DETECTOR BACKGROUND AND SENSITIVITY OF X-RAY FLUORESCENCE SPECTROMETERS. **Goulding, F. S.; Jaklevic, J. M.; Jarrett, B. V.; Landis, D. A.** (California Univ., Berkeley. Lawrence Radiation Lab.). 16 Jul 1971. Contract W-7405-eng-48. 17p. (CONF-710802-4). Dep. NTIS.

From twentieth annual conference on applications of x-ray analysis; Denver, Colo. (11 Aug 1971).

Degraded detector pulses are shown to contribute most of the background in spectra produced by silicon semiconductor-detector x-ray spectrometers. A new guard-ring detector is used with appropriate circuits to reduce background by a large factor. The sensitivity of the new arrangement with various excitation sources is discussed. (auth)

51857 (RDT-C-15-3-T) CURRENT PULSE PREAMPLIFIERS FOR USE WITH FISSION COUNTERS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Aug 1971. 30p. RSO.

A standard for the required performance, test procedures, and construction materials for preamplifiers for fission chambers is presented. Three types of preamplifiers are covered including single ended input and output, differential input and single ended output, and differential input and output. (W.H.K.)

51858 CHARGE COLLECTION IN Ge(Li) GAMMA COUNTERS. **Novikov, S. R.; Novogrudskii, B. V.; Pustovoit, A. K.; (and others)** (Physical-Tech. Inst., Leningrad). Fiz. Tekh. Poluprov.; 4: 1039-45(Jun 1970). (In Russian).

A connection between the effective lifetime of a current carrier, appearing during charge collection in Ge(Li) gamma counters, and the lifetimes determined by various procedures in the parent material is established. For a large fraction of the crystals investigated, a correlation was observed between the effective lifetime of a current carrier and the value of the original lifetime measured at 78°K for a short-circuited diode, prepared from the parent material and irradiated by γ-quanta, or else by the method of injection-extraction. (tr-auth)

51859 HIGH-RESOLUTION SCINTICAMERA BASED ON DELAY-LINE TIME CONVERSION. **Nohara, N.** (National Inst. of Radiological Sciences, Chiba, Japan); **Tanaka, E.; Hiramoto, T.; Kumano, N.; Kakegawa, M.** J. Nucl. Med.; 12: No. 9, 635-6(Sep 1971).

Improvements in the electronics system and the image detector of the new scinticamera based on delay-line time conversion are briefly described. The system resolving time (4.5 μsec), spatial resolution (8.0 mm fwhm for ^{57}Co), and energy resolution (13 to 14% fwhm for ^{57}Co) are discussed. (W.H.K.)

51860 INVESTIGATION OF BROADBAND CURRENT PREAMPLIFICATION FOR OBTAINING SIMULTANEOUS HIGH-RESOLUTION ENERGY AND TIME INFORMATION FROM NUCLEAR RADIATION DETECTORS. **Millard, Joe Kenneth.** Knoxville, Tenn.; Univ. of Tennessee (1970). 154p. University Microfilms Order No. 71-17,761.

Thesis.

In beginning the investigation of low noise current preamplification, noise-performance limitations of existing broadband current-amplifying stages are considered. Dominant noise sources of the general, shunt-feedback amplifier stage having both bipolar and field-effect transistor input devices are discussed. This discussion includes the reasons why optimum noise performance from this amplifier stage requires unavoidable signal integration. The integrating shunt-feedback configuration is commonly known as the charge-sensitive preamplifier. Criteria are developed for differentiating the output voltage pulse of the charge-sensitive preamplifier without degrading the signal-to-noise ratio. Subsequently, a new broadband, shunt-feedback amplifier is described having a current gain equal to the ratio of an RC feedback impedance to an RC load impedance. A three-stage preamplifier having a current gain of 8000 was constructed to experimentally verify the predicted preamplifier performance characteristics. Energy resolution experiments performed with a Ge(Li) semiconductor detector yielded noise line widths as low as 2.35 keV fwhm for the integrated current output shaped by a 1.6 microsecond time constant RC-RC filter. The noise line width measured for the gated current pulse shaped by the RLC filter was 2.70 keV fwhm compared to 2.76 keV fwhm obtained, without gating, from a 0.4 microsecond RC-RC filter having the same center frequency as the RLC filter. The preamplifier was not optimized for minimum noise line width. Leading edge timing experiments were performed with a ^{60}Co gamma-ray source using Naton 136 as the detector for the standard timing channel. With the test channel consisting of the three-stage preamplifier coupled to a 1.7 cc planar diode, a timing uncertainty of 1.6×10^{-9} seconds fwhm for a 13.3 to 1 dynamic energy range was measured. With a 34.1 cc true coaxial Ge(Li) detector in the test channel, the timing uncertainty was 3.3×10^{-9} seconds fwhm for a 7.8 to 1 dynamic energy range. Rise times as low as 7×10^{-9} seconds were measured with the 9×10^{-12} farad planar detector connected to the preamplifier. (TSS) (Diss. Abstr. Int., B)

51861 MATERIALS PROBLEMS IN LITHIUM-DRIFTED GERMANIUM RADIATION DETECTORS. **Jindal, Gopi Ram.** University Park, Pa.; Pennsylvania State Univ. (1970). 88p. University Microfilms Order No. 71-16,618.

Thesis.

A study on the problems of yields and physics of failure in lithium drifted germanium gamma detectors is described. The germanium was examined by Transmission Electron Microscopy (TEM) for microinhomogeneities (both chemical and structural). In addition, some simple fused junction devices were fabricated to characterize the material and to correlate their results with TEM studies. The following types of germanium were examined: (a) pure germanium, (b) gallium-doped starting material vertical and horizontal grown (both good and bad drifters), (c) indium-doped starting material vertical and horizontal grown (both good and bad drifters), (d) lithium-drifted material (both good and bad drifters), (e) gallium-doped germanium heat treated for 10 minutes at 400°C, (f) detector material irradiated at 11.1 μ-curies from ^{60}Co source. Pure germanium was grown by horizontal technique. Gallium-doped and indium-doped germanium were grown by Czochralski and horizontal techniques. Lithium was drifted into gallium-doped material by a standard lithium drifting technique. TEM was the principal characterization tool. The instruments used were the Hitachi HU 11 and the Philips EM 300 electron microscopes. Selected area diffraction patterns were also taken. The electrical response of diodes fabricated from the experimental materials was used as an additional characterization tool. The study showed that indium-doped material was better as compared to gallium-doped and may be more promising for gamma ray detectors than gallium-doped material. Heat treated gallium-doped material appeared to be similar to the lithium drifted good drifter material. It appeared that the defects were getting into the material during lithium drifting steps due to the temperature effect. Irradiation did not affect the material at the required working radiation doses of approximately 10 μ-curies. Higher breakdown voltages for good drifter than bad drifter materials were achieved. (TSS) (Diss. Abstr. Int., B)

51862 APPLICATION OF CATHETER-TYPE SEMICONDUCTOR RADIATION DETECTOR (CASRAD) TO THE PULMONARY FUNCTION STUDIES. **Mori, Masashi; Koike, Shigeo; Iio, Masahiro; Shiraishi, Toru; Morinari, Hajime** (Tokyo Univ.). Jap. Heart J.; 11: No. 4, 345-64(Jul 1970).

A new approach to the measurement of pulmonary function was attempted by the use of catheter-type semiconductor radiation detector (CASRAD). From the basic and model experiments, it is concluded that the ratio of ^{85}Kr counting rates in different bronchi measured by CASRAD can be compared as the concentration ratio of ^{85}Kr if these bronchi are similar in size. Three dogs were used for animal experiments. Krypton-85 solution was injected as a bolus into the right side of the heart and the counting rate was measured in the upper and the lower lobe bronchus where the CASRADs were placed. The maximum counting rates were essentially the same in the upper and the lower lobe bronchus for the supine position, while they tended to get higher in the lower lobe for the head-up position. This phenomenon was explained by the increase of perfusion to the dependent zone of the lung due to the gravity. The approximation of the perfusion ratio between the upper and the lower lobe by the ratio of the maximum counting rate was also attempted. When washout rates of ^{85}Kr in the upper and the lower lobe were compared, there was no significant difference between them whether the dogs were placed supine or head-up. As a preliminary study for clinical application, CASRAD was used for the measurement of ventilatory efficiency, lobar function, and bronchospirometry. The clinical applicability was confirmed. The advantages and limitations were discussed comparing CASRAD with the external counting method. (Japan)

51863 ^{10}B SLAB DETECTOR FOR TOTAL NEUTRON CROSS-SECTION MEASUREMENTS. Hussain, M. (Univ. of Dacca, Pakistan); Shahabuddin, A. M.; Vuister, P. H.; Molla, N. Islam. Nucl. Sci. Appl., Ser. B; 5: 43-4(Oct 1969).

The operation of a NaI(Tl) scintillation detector with a boron-10 slab for detecting neutrons in the 100-keV range is described. The setup was used to measure the total neutron cross section of sulfur around the 111 keV resonance. (W.H.K.)

51864 AUTOMATIC EQUIPMENT FOR STUDYING THE DISTRIBUTION OF THE INTENSITY OF γ RADIATION WITH RESPECT TO THE LENGTH OF IRRADIATED MATERIALS (EXCHANGE OF EXPERIENCE). Davydov, E. F.; Gordienko, P. S.; Kolesov, V. V. Ind. Lab. (USSR) (Engl. Transl.); 36: No. 10, 1627(Oct 1970).

Translated from Zavod. Lab.; 36: No. 10, 1281(Oct 1970).

A NaI(Tl) scintillation detector system for the gamma scanning of irradiated heat-producing elements is described. (W.H.K.)

51865 SPATIAL STATISTICS OF A GAMMA CAMERA. Jackson, G. L.; Hadcock, W. (Harrisburg Hospital, Pa. Pennsylvania State Univ., University Park). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 760-3(Aug 1971).

A technique for the computer analysis of the uniformity of response of the Digital Autofluoroscope to a uniform radioactive source is presented. (auth)

51866 DETERMINATION OF THE MODULATION TRANSFER FUNCTION (MTF) USING A PROGRAMMABLE CALCULATOR. Goldsmith, William A.; Nusynowitz, Martin L. (William Beaumont General Hospital, El Paso, Tex.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 806-11(Aug 1971).

An algorithm has been developed for the automated determination, by an iterative technique, of the modulation transfer function for the line spread function data. A programmable desktop calculator may be used for the determination. Examples illustrating the utility of the program are presented. (auth)

51867 IMPROVED POSITION-SENSITIVE RADIATION DETECTOR. (to United States Atomic Energy Commission). British Patent 1,245,312. 8 Sep 1971. Priority date 24 Oct 1968, United States.

An improved position-sensitive ionization chamber with a high-resistance charge collection electrode is described. A time reference electrode is positioned parallel to the high-resistance charge collection electrode. (W.H.K.)

51868 TIMING CHARACTERISTICS OF COAXIAL Ge(Li) DETECTORS. Poenaru, D. N.; Stuck, R.; Siffert, P. (Centre de Recherches Nucleaires, Strasbourg). Rev. Roum. Phys., 16: No. 3, 305-18(1971). (In French).

A theoretical study of the charge collection and timing properties of coaxial Ge(Li) detectors is presented. Analytical relationships are derived for the current and charge pulses. Different coaxial geometries and locations of gamma-ray interaction points are considered. Prompt coincidence curves for various discriminator thresholds and noise levels are calculated using numerical methods. (auth)

51869 TRITIUM STACK MONITOR (29 Apr 1971) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-2110).

25 drawings.

A stack monitoring system is described which gives an immediate indication of the total amount of T released during a period of time in the range of one to 10^7 Ci. The system consists of an air mover (not described), a one liter ion chamber, a MOSFET current-to-frequency converter, a seven-decade accumulator, a six-decade scaler-timer, and a printer. The scaler activates an alarm when activity is released that exceeds preset levels at any time during a ten minute period. In each ten minute period, the scaler prints out and resets providing a continuous record of T release. The accumulator operates in parallel with the scaler and sums the activity released until the accumulator is manually reset. The scaler, accumulator, and printer are visually displayed at the central control panel. (For details see TID-4100 Suppl. 66) (F.S.)

51870 TENTATIVE METHOD FOR FAST-NEUTRON FLUX MEASUREMENTS BY TRACK-ETCH TECHNIQUE. ASTM E418-70T. Philadelphia; American Society for Testing and Materials (1970). 5p. Available from American Society for Testing and Materials, Philadelphia.

The measurement of neutron flux by the use of fissionable materials is discussed. Fission fragments emitted by the fissionable materials during neutron bombardment penetrate a suitable recording medium, such as plastic, glass, or mica, that is in contact with the fissionable material. Appropriate etching techniques render the path of the fragment in the recording medium visible under an optical microscope. Since measurement of the decay of radioisotopes is not involved in the method, irradiation times are limited only by the maximum number of fission-fragment tracks that can be clearly distinguished without pile-up—approximately 2×10^5/cm^2. The neutron-energy range over which the common fissionable materials are useful is between 1 keV and 18 MeV. As with other methods used to determine neutron flux, the uncertainties in some cross-section data make it difficult to assign an over-all accuracy value to this method. (R.W.R.)

51871 GAS DISCHARGE NEUTRON COUNTER. Golovanov, N. A.; Kozodaeva, N. M.; Korotin, B. A.; (and others). Russian Patent 270,108. 8 May 1970. Filed 4 Sep 1967. (In Russian).

A gas discharge counter for neutron detection is described. One end of the counter has a thin window to permit calibration by charged particles. (R.W.R.)

51872 STREAMER CHAMBER FOR LOW-ENERGY APPLICATIONS. Rice-Evans, P.; Mishra, S. R. (London Univ.). J. Phys., E (London); 4: 638-40(Sep 1971).

A streamer chamber for recording the tracks of low-energy charged particles is described. An essential feature is the incorporation of plastic phosphor as one wall of the chamber, to enable the chamber to be triggered. (auth)

51873 ON-LINE NOBLE GAS FISSION PRODUCT MONITORING IN EXPERIMENTAL BREEDER REACTOR II. Brunson, G. S. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Technol.; 10: No. 1, 33-43(Jan 1971).

As part of the defective-cladding detection program at EBR-II, the Reactor Cover Gas Monitor was installed to provide on-line monitoring for noble-gas fission products in the argon cover gas filling the reactor vessel above the sodium coolant. With a 2 × 2-in. sodium iodide scintillator as the detector, it has been possible to identify ^{133}Xe, ^{85m}Kr, and ^{135}Xe, which are always present in low concentrations due to an irreducible background fission source in the reactor. This apparently straight-forward monitoring project turned out to be more complicated by the presence of relatively large concentrations of ^{23}Ne [from the reaction ^{23}Na(n,p)^{23}Ne on the sodium coolant]. The ^{23}Ne diffuses from the sodium to the cover gas at a rate which is exceedingly sensitive to the bulk-sodium temperature. Small temperature changes can produce large changes in the ^{23}Ne concentration. The Compton continuum from ^{23}Ne is counted in the channels adjusted for the fission-product gases, causing large and alarming surges in the indicated concentrations. While this effect is not yet understood, it has been alleviated by "aging" the sample stream in a delay line to permit additional decay of the 38-sec ^{23}Ne. After the delay line was installed, it was possible to monitor ^{135}Xe very effectively; ^{133}Xe and ^{85m}Kr still could not be monitored clearly because of the interference from the Compton continua of higher energy gamma lines, principally that of ^{135}Xe. (auth)

51874 IMPROVEMENTS IN PERFORMANCE OF A LIQUID HELIUM SCINTILLATION COUNTER. Martin, J. C.; Broste, W. B.; Simmons, J. E. (Los Alamos Scientific Lab., N. Mex.). pp 877-9 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

51875 SIMPLE AND STABLE LIQUID HELIUM NEUTRON POLARIMETER. Katori, K.; Furuno, K. (Tokyo Univ. of Education). pp 880-1 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

51876 WIRE SPARK CHAMBERS FOR CLINICAL IMAGING OF GAMMA-RAYS. Kaufman, L. (Univ. of Califonria, San Francisco); Perez-Mendez, V.; Rindi, A.; Sperinde, J. M.; Wollenberg, H. A. Phys. Med. Biol.; 16: No. 3, 417-26(Jul 1971).

Spark chambers with digitized read-outs offer distinct advantages in spatial resolution and coverage over other γ-ray imaging devices. While these chambers usually require external logic signals for triggering, a method is described that provides self-

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triggering spark chambers. Initial tests of a 45 × 45 cm externally triggered spark chamber with ^{60}Co and ^{198}Au samples are described and future developments are mentioned. (auth) (UK)

51877 OFF-LINE DIGITAL SYSTEM FOR USE WITH A GAMMA CAMERA. Vernon, P.; Glass, H. I. (Hammersmith Hospital, London). Phys. Med. Biol.; 16: No. 3, 405-15(Jul 1971).

A system for the off-line collection of data from a gamma camera is described. The data are digitized, buffered, and recorded on computer-compatible magnetic tape, together with timing information. A program for processing the magnetic tape records on a powerful, batch-processing computer (CDC 6600) is described briefly. The performance and characteristics of the system are described, and the merits of such a system are discussed relative to small dedicated computer systems attached to gamma cameras. (auth) (UK)

51878 DEVICE FOR DIAGNOSIS WITH RADIOACTIVE ISOTOPES. Prag, Rudolf; Tschunt, Edgar (to Siemens Aktiengesellschaft). U. S. Patent 3,591,808. 6 Jul 1971. Priority date 5 Jan 1968, Germany.

This apparatus for isotope diagnosis has a measuring device for determining the distribution of radioactive substances in a body from rays emitted by these substances. The device includes an element sensitive to these rays and located in a housing made of a material that does not transmit the rays. The ray-sensitive element has a surface receiving the rays and covered by a collimator that can be pushed into the housing. One collimator may be exchanged for other collimators of different lengths, the length of the housing being at least equal to that of the longest collimator plus the length of the ray-sensitive element. The invention is particularly characterized in that the ray-sensitive element is also movable in the direction of the longitudinal axis of the housing. The ray-sensitive element and the collimator are joined, and the surface of the collimator that receives the incoming rays is located in an opening of the screening housing. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 53408 and 53750.

51879 (CONF-701002–, pp 385-400) NEUTRON SPECTROSCOPY WITH PROTON-RECOIL PROPORTIONAL COUNTERS. Bennett, E. F.; Yule, T. J. (Argonne National Lab., Ill.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

Techniques and analyses for fast-neutron spectroscopy with proton-recoil proportional counters are described. Small nonperturbing counters filled with hydrogen or methane are used in an isotropic flux environment to measure degraded fission spectra in the energy range from 1 keV to 2 MeV. Electronic pulse-shape discrimination distinguishes between gamma-ray-induced events and proton recoils. Corrections to the measured proton-recoil spectrum which enable one to obtain the ideal proton-recoil spectrum, i.e., the one that leads to the true neutron spectrum, are considered. The corrections include those for the nonlinear relation between energy and ionization at low energies, for wall and end effects at higher energies, and for effects introduced by the distortion of internal field lines at the ends of the counter. Spectra measured in a fast test reactor and in an irradiation room of a facility intended for fast-neutron-related biological studies are included. (auth)

51880 (CONF-701002–, pp 401-9) EXPERIMENTAL TESTS WITH THE TIME-OF-FLIGHT METHOD ON A NEUTRON DETECTOR WITH FLAT ENERGY RESPONSE. Coates, M. S.; Hunt, G. J.; Uttley, C. A.; Rae, E. R. (Atomic Energy Research Establishment, Harwell (England)).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

A neutron detector with a flat energy response has been designed and built. The detector consists of a Vaseline–boron-10 sphere with NaI detectors at the surface for detecting the 478-keV γ rays from the ^{10}B(n,α)^{7m}Li reaction. The detector has a time response that is fast enough to be used in time-of-flight experiments. Preliminary measurements on the 300-m flight path of the Harwell 45-MeV Linac spectrometer, which test the Monte Carlo calculations of the energy response, are reported. The neutron-energy range covered in these experiments is approximately 1.5 keV to 1 MeV. (auth)

51881 (N-71-17323) PREJUD: A COMPUTER CODE FOR THE PRELIMINARY ANALYSIS OF TWO-DIMENSIONAL PULSE HEIGHT ANALYZER DATA. Semler, Thor T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb 1971. 31p. (NASA-TM-X-2181; E-5824). NTIS.

A computer program for the processing of two-dimensional analyzer pulse-height data, which provides an automated separation of gamma counts from neutron counts, and produces data in a format suitable for input to a spectrum unfolding code, is described. A strategy for the separation of gamma and neutron counts is detailed. Data smoothing techniques and a spline interpolation technique are described. (auth) (STAR)

51882 (PEL-204) INVESTIGATION INTO THE DIFFERENT COMPUTER TECHNIQUES AVAILABLE FOR THE ANALYSIS OF GAMMA-RAY SPECTRA OBTAINED WITH A LITHIUM-DRIFTED GERMANIUM DETECTOR. Turkstra, J.; van Rensburg, M. C. J.; de Wet, W. J. (Atomic Energy Board, Pelindaba, Pretoria (South Africa). Aug 1970. 42p. Dep. NTIS (U. S. Sales Only).

Methods for analysis of photopeak counts in γ-spectra were investigated for high-resolution γ-spectrometry, using a 400- and 4000-channel analyzer. For this evaluation study different published computer techniques were applied to analyze counts of particular photopeaks in specially recorded γ-spectra. The results obtained are compared and discussed. (auth)

51883 SOME IMPROVEMENTS IN A NEUTRON TIME-OF-FLIGHT SPECTROMETER FOR D + T NEUTRONS. Hyakutake, Mikio; Matoba, Masaru; Tawara, Hiroyuki; (and others) (Kyushu Univ., Fukuoka). Jap. J. Appl. Phys.; 10: No. 8, 1090-6(Aug 1971).

Some improvements in a neutron time-of-flight spectrometer using the associated particle method are described. A simple circuit is devised to compensate the dependence of a flight-time of neutrons of a given energy on the pulse height of the output signals of the neutron detector. By the use of this circuit in the time-of-flight spectrometer, a time resolution of 1.2 nsec (fwhm) is obtained for direct neutrons from the D + T source. The spectrometer system is also so improved that two neutron detectors operate together with a single set of circuits for n-γ discrimination and time-to-pulse height conversion. The effects of the shadow bar and detector shielding on the background level are studied. The background is reduced by an order of magnitude by the use of a suitable shadow bar and detector shield. (auth)

51884 PROGRAM FOR COMPUTER PROCESSING OF CONTINUOUS TIME-OF-FLIGHT SPECTRA OF INELASTICALLY SCATTERED NEUTRONS. Giera, H.-D., Hoehn, J.; Seeliger, D.; Seidel, K.; Wohlfahrt, D. (Technical Univ., Dresden). Kernenergie; 14: No. 4, 115-21(Apr 1971). (In German).

The physical substance of work necessary for treatment of experimental continuous time-of-flight spectra of inelastically scattered neutrons to a stage that theoretical analysis can begin is described. The problems dealt with include inspection of measured values, time-to-energy transformation, laboratory-to-center of mass system transformation, calibrations, normalizations, corrections, and smoothing procedures. (auth)

51885 FAST NEUTRON SPECTROMETRY: ESPECIALLY WITH THE USE OF THE PROTON RECOIL PROPORTIONAL COUNTER. Albert, D. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 14: No. 4, 97-101(Apr 1971). (In German).

Methods of fast neutron spectroscopy are discussed, especially the proton recoil proportional counter spectrometer. Experimental techniques and methods of evaluation are described in detail. (27 references) (auth)

51886 DEVELOPMENT OF A SPECTROMETER AND THE MEASUREMENT OF THE NEUTRON SPECTRUM FROM THE HEALTH PHYSICS RESEARCH REACTOR BETWEEN 50 keV AND 450 keV. Stone, Donald R. (Chattanooga State Technical Inst., Tenn.); Thorngate, John H. Health Phys.; 21: No. 3, 441-8 (Sep 1971).

A proton-recoil telescope neutron spectrometer was developed to measure neutrons having energies between 50 keV and 450 keV. The proton radiator was a 17 μg/cm^2 thick anthracene film separated a distance of 83.82 cm from a ZnS scintillation detector. A magnetic analyzer was used between the radiator and detector to determine the momentum of the recoiling protons. The ORNL 3 MeV Van de Graaff accelerator was used to obtain the detector response as a function of proton energy, and the DOSAR Low Energy Accelerator was used to calibrate the magnetic field of the spectrometer. Spectral measurements of neutrons with energies between 50 keV and 450 keV were made 50 cm from the Health Physics Research Reactor. The results agreed well with a portion of measurements made previously with a ^{6}Li spectrometer, but the agreement with a calculated form of the Godiva 2 spectrum for this energy region was not as good. However, good agreement with the Godiva 2 spectrum for the energy region of interest would not be expected, since the Godiva 2 core configuration is smaller than the HPRR and the fuel is not alloyed with molybdenum as is the HPRR. (auth) (UK)

51887 IMPROVEMENTS ON A MEASURED SPECTRUM OF COSMIC-RAY PRODUCED NEUTRONS. Aurela, A. M.; Vuorinen, K. J. (Turku Univ., Finland). Ann. Univ. Turk., Ser. AI; No. 142, 1-7(1970).

Methodological error sources in a previous measurement of the energy spectrum of evaporation neutrons produced by cosmic rays in lead were studied. The reduction of the measured background rate of the spectrometer by the insertion of the lead target of the actual measurements was estimated mainly theoretically. The influence of this effect on the counting-rate distribution was found to be comparatively small. The scattering of the evaporation neutrons from the background shield of the spectrometer was studied mainly experimentally by means of Th–Be and Ra–Be neutron sources. After the present corrections, the results of the measurement agree with the theory of nuclear evaporation. The experimental value obtained for the mean energy of the evaporation neutrons is 3 MeV. (auth) (Finland)

51888 AUTOMATIC ANGULAR CORRELATION MEASURING SYSTEM. Nurkkanen, P.; Sutela, V. (Turku Univ., Finland). Ann. Acad. Sci. Fenn., Ser. A VI; No. 343, 1-7(1970).

A simple, inexpensive control system for measurements of angular correlations and its construction are described. (auth) (Finland)

51889 IONIZATION CHAMBER FOR THE DOSIMETRY OF 14 MeV NEUTRON BEAMS. Greene, D. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Phys. Med. Biol.; 16: No. 3, 489-96(Jul 1971).

A cylindrical ionization chamber with polythene walls, central electrode, and thin carbon conducting surfaces is described. Its calibration for measuring absorbed dose in a medium irradiated with a fast neutron beam is discussed. The dose to soft tissue is given by $D_T = 0.79\ x_c/R_c\ R_T$, where R_c is the reading obtained with the chamber given an exposure x_c roentgens of ^{60}Co γ-rays, and R_T is the reading obtained in the neutron beam. It is estimated that the uncertainty on D_T is ±6%. (auth) (UK)

High Energy Physics Instrumentation

Refer also to abstracts 53017, 53132, and 53343.

51890 (IFVE-SPK-70-61) SUPERVISOR PROGRAM FOR THE BESM-4 COMPUTER. Sherbakov, E. D. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

A special superviser program for the BESM-4 computer connected on line with bubble chamber film scanning-measuring devices is described. This program provides multiprogramming of the computer. (auth)

51891 (JINR-P13-5780) TRACK CHAMBER WITH THE CHARGE MULTIPLICATION INSIDE THE FILM ELECTRODES. Nikanorov, V. I.; Pisarev, A. F.; Selivanov, G. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

Charge multiplication, observed in porous dielectrical and semiconductor films, when supplying electrical field, is considered from the point of view of construction of coordinate chamber and counters for charged particle recording basing on this effect. The variant of construction of track chamber using the boundary luminescence of media is also considered. (auth)

51892 (JINR-P13-5896) INFORMATION PROPERTIES OF PARTICLE TELESCOPE CONSISTING OF MULTIPLEX SCINTILLATION COUNTERS. Soroko, L. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The particle telescope consisting of two multiplex Hadamard-transform scintillation counters is described. Each scintillator is set up with many-element scintillators which are surrounded by light-guides and four photomultipliers. Four coincidence circuits register the four groups of events. The coincidence countings define the intensity of the angular correlation events from the two-particle ones. And the angular discrimination of the events to be measured is equal to the angle which subtends the only one element-scintillator of the multiplex scintillation counter. (auth)

51893 (KFK-1191) MANY-COUNTER EXPERIMENT IN HIGH-ENERGY PHYSICS IN THE CAMAC SYSTEM WITH A TELEFUNKEN CALCULATOR TR 86 A. Bouharrour, S.; Gruber, P.; Lenhardt, H.; Ottes, J. (Kernforschungszentrum, Karlsruhe (West Germany). Labor fuer Elektronik und Messtechnik). Apr 1971. 54p. (In German). Dep. NTIS (U. S. Sales Only).

The rather high data rate at the experiment "Neutral Resonances" at CERN in Geneva demands on-line data acquisition by a process computer. The CAMAC system offers a flexible and efficient method of interfacing experiment electronics to a computer. Different types of modules from various groups of physicists — e.g. from the University of Pisa — could be easily plugged into the system on the grounds of the compatibility of CAMAC equipment (EUR 4100 e, d, f, i). The most frequently used module — a four fold 16-bit scaler — was already available off the shelf. Other units including a system controller, two crate controllers, dynamic parallel output and punch control for emergency case have been especially designed. Details of the electronic system and the basic software structure are given. During the total running time of 14 months for the experiment, the hardware did not fail. (auth)

51894 (RHEL/R-218) STUDY OF THE HOMOGENEITY AND STOPPING POWER OF NEON-HYDROGEN MIXTURES IN THE 1.5 METRE BUBBLE CHAMBER. Atchison, F.; Fisher, C. M. (Rutherford High Energy Lab., Chilton (England)). Jul 1971. 12p. Dep. NTIS (U. S. Sales Only). UK 20p.

Measurements of the uniformity of neon-hydrogen liquid mixtures, in the region of 50 mole per cent neon, were made in the 1.5 metre bubble chamber for a series of filling techniques. Protons of ~750 MeV/c were stopped in the liquid and variations of range with depth used to check uniformity to $\simeq \pm\frac{1}{2}\%$. Absolute concentration measurements are also reported. It is concluded that uniform mixtures can be achieved using an established filling procedure. Concentrations measured using this technique are generally higher than those measured from sampling the liquid directly. (auth) (UK)

51895 (RHEL/R-223) CALIBRATION OF IMAGE-PLANE DIGITIZERS. Gopal, G. P. (Rutherford High Energy Lab., Chilton (England)). Jul 1971. 10p. Dep. NTIS (U. S. Sales Only). UK 15p.

A new system of calibration of digitizers is described and details of the procedure and the computer program used are given. The system is general in its application to conventional measuring machines, but is mainly used to calibrate image digitizers. Calibration of digitizers with lens or film-plane shifts is systematically handled in the system. (auth)

51896 (UCRL-20636) ON-LINE SCINTILLATION COUNTER CONTROL SYSTEM. Graven, R. M.; Andreae, S. W.; Brewer, J. H.; Budnitz, R. J.; Entis, A. C.; Kirsten, F. A.; Lee, K. L.; McCarthy, R. L.; Miller, D. H.; Ross, W. N. (California Univ., Berkeley. Lawrence Radiation Lab.). 9 Mar 1971. Contract W-7405-eng-48. 14p. (CONF-711011-1). Dep. NTIS.

From Eurocon computer applications conference; Lausanne, Switzerland (18 Oct 1971).

An on-line data collection system was built and used at the Lawrence Radiation Laboratory's Bevatron to measure the charge asymmetry in the decay $K_L^0 \to \pi^\pm \mu^\mp \nu$. The system records the states of 144 scintillation counters arranged into twelve hodoscopes, and it can test the operation of each counter. Information from pulse height analyzers, a digital voltmeter, time-to-amplitude converters, event clock, and scalers was recorded with each event. Using a PDP-9 computer, over 25 million events were recorded on magnetic tape during the tuning and data phases of the experiment. A CRT, programmed to display histograms and geometrical models of the experimental information as it was accumulated, was a valuable diagnostic tool allowing rapid visual assessment of both broad hodoscope and specific counter anomalies. The computer's power was greatly expanded by the addition of external control registers, hardware priority resolvers, event matrix logic, additional programmable flags, and input-output transfer request lines, in addition to software priority levels and the usual program interrupt line and peripherals. Inexpensive dual discriminators, nanosecond coincidence gates, testing circuits and new packaging methods were all used in developing this system. (auth)

51897 EXPERIMENTAL STUDY OF TRANSVERSE TRACK GEOMETRY IN NUCLEAR EMULSIONS. Friedlaender, J. B. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 5, 547-55(1971).

The distribution of lateral displacements of emulsion grains from the particle path of 10 GeV protons has been studied on intermediate microphotographs. The shape of this distribution is evidence in favour of nonsuperficial topography of sensitivity

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centers in the grain. Previous results indicating proportionality between the initial grain radius and the width of the displacement distribution are confirmed by more direct methods. (auth)

51898 DEVICE FOR MOVING A MOVABLE ROD BACK AND FORTH. Pacchioni, Antenore (to Commissariat a l'Energie Atomique). British Patent 1,244,107. 25 Aug 1971. Priority date 29 Feb 1968, France.

A device suitable for use in the expansion system of a bubble chamber is described. It produces a rapid, single-stroke movement in one direction followed by a rapid, single-stroke movement in the opposite direction. As movement of only a small quantity of hydraulic fluid is required, a low-power pump is sufficient. (R.W.R.)

51899 GEOMETRICAL FIT OF BUBBLE CHAMBER TRACKS BY TREATING SCATTERING AS MEASUREMENT ERROR. Laurikainen, P. (Univ. of Helsinki). Commentat. Phys.-Math.; 41: No. 2, 131-48(Jun 1971).

The so-called matrix approach to improved geometrical reconstruction of particle trajectories is investigated under small-angle multiple scattering. By means of the stochastic integral representation, the statistical properties of lateral displacements induced by the Gaussian scattering process are determined when trajectories are curved by a strong, homogeneous magnetic field. The standard method of reconstructing bubble-chamber tracks is then generalized by considering the influence of these displacements on measurement errors. The expression of image-plane displacement is extended to non-conventional optics. The usefulness of the matrix approach seems to be seriously restricted by the numerical difficulties arising from the handling of large matrices. (auth) (Finland)

51900 APPARATUS FOR OBTAINING ISOTROPIC IRRADIATION OF A SPECIMEN. Katz, Lester. (to National Aeronautics and Space Administration). U. S. Patent 3,593,024. 13 Jul 1971. Filed 3 Sep 1969.

Apparatus for moving a film emulsion in a path of high-energy particles so as to obtain essentially an isotropic exposure is described. The apparatus rotates the film on a turntable along one axis and simultaneously shifts the turntable up and down within a limited range. (auth)

51901 PHOTOGRAPHIC APPARATUS FOR THE BUBBLE CHAMBER TRACKS. Murata, Kazumi; Matsui, Hiroyuki; Nakajima, Kazutoshi; Watanabe, Yasuyoshi; Matsuura, Shigeru (Government Industrial Research Inst., Osaka). Osaka Kogyo Gijutsu Shikenjo Kiho; 21: No. 4, 169-98(Dec 1970). (In Japanese).

A photographic apparatus for bubble chamber track study was designed, and its performance tests were carried out. A retrodirective illumination system of a bubble chamber was mathematically analyzed. "Scotchlite" was used as a retrodirective reflector, and a xenon ring flash tube around an objective lens was used as a light source. The intensity distribution of bubble images and that of the background field were obtained for various values of radius of the ring flash tube, and an optimum radius of the ring flash tube was estimated. Measurement of retrodirectivity of the reflectors was also performed. A ray-tracing method with a computer and image evaluation with spot diagrams was widely used for designing the lens for a bubble chamber camera. Required specifications and performances are as follows: 125 mm focal length, 47° view angle, 5.6 ratio of aperture, 120 mm ϕ size of image field, 1,675 mm object distance, 100 lines/mm resolving power less than 0.007% distortion and greater than 50% ratio of marginal illumination. The test results showed that the design was adequate for present use. The camera was made of nonmagnetic material, and required the following specifications: 70 mm film size with perforation, 70 mm × 70 mm frame size, up to 10 frames/sec exposure, and 200-feet or 1,000-feet film cassette. Reliability of operation was confirmed. Testing of the overall apparatus was performed, and the results were satisfactory. (Japan)

51902 PROPOSAL FOR A NEW HIGH PRECISION PARTICLE DETECTOR. Rice-Evans, P. (Bedford Coll., London). Nature (London); 232: No. 5313, 625-7(27 Aug 1971).

It is stated that with the introduction of a new generation of synchrotrons there is a need for instruments of better resolution for measuring the position of charged particle tracks, arising from the fact that the accelerated particles will receive only small deflections in analyzing magnets. A detector is described which it is claimed will provide the necessary increase in resolution. The detector is of the proportional type in which the collecting wire is made the cathode, as opposed to conventional instruments in which the wire is the anode. The filling gas is Ar. The resolution is claimed to be ~30 μm, but this is accompanied by low efficiency. The term "outwardly directed avalanche chamber" is applied to this type of instrument. (UK)

Radiation Dosimeters

Refer also to abstracts 52022, 52078, 52082, 52088, and 52910.

51903 (COO-1105-166) FAST NEUTRON RADIATION DAMAGE IN ANTHRACENE AS A POSSIBLE DOSIMETER. Pearson, David W.; Moran, P. R. (Wisconsin Univ., Madison. Dept. of Physics). [1970]. 19p. Dep. NTIS.

Experiments were performed on the effects of fast neutron exposures (2.5 and 14 MeV) on the triplet exciton lifetime and the delayed fluorescence intensity in anthracene crystals. The effect of low doses is to increase the triplet exciton monomolecular decay rate. The sensitivity constant shows a sample dependence. The usefulness of this effect as a rad dosimeter is limited to doses >10 rads. (D.L.C.)

51904 (CO-1105-168) PART I. EVALUATIONS OF RAMAN EFFECTS FOR DETECTING FAST NEUTRON INDUCED RADIATION DAMAGE. PART II. ELECTRON SPIN RESONANCE MEASUREMENTS IN DOSIMETRY RESEARCH. Moran, P. R. (Wisconsin Univ., Madison. Dept. of Physics). [nd]. 4p. Dep. NTIS.

I. The evaluation shows that relativistic limitations on present sample perfection and instrumentation excludes the Raman effect as a practical technique for low-level dosimetry. II. For the alanine-based ESR dosimeter technique, experimental sensitivity is in agreement with the estimated detection level (~10 Rad) for fast neutrons. (D.L.C.)

51905 COMPARISON OF TISSUE-EQUIVALENT IONIZATION CHAMBERS AND SILICON DIODES FOR MEASURING FAST NEUTRON DOSE. Batchelor, A. L. (Medical Research Council, Harwell, Eng.). Phys. Med. Biol.; 16: No. 3, 451-9(Jul 1971).

Tissue-equivalent ion chambers and thermoluminescent dosimeters were used to measure fast neutron dose in large tissue-equivalent phantoms. Gamma-rays were present in addition to fast neutrons, and since the ion chambers responded to the combined dose from these radiations, the γ-ray dose component was measured separately with thermoluminescent dosimeters. The fast neutron doses were also measured with silicon diodes by utilizing the decrease in electrical conductance of the diode, caused by damage to the silicon crystal lattice. Gamma-rays did not affect the diode conductance significantly. The diodes underestimated the neutron dose by amounts which depended on depth in the phantoms, and correction factors are given. (auth) (UK)

51906 THERMOLUMINESCENT RESPONSE OF THE MIXTURE OF $CaSO_4$(Mn) AND Li_2SO_4 TO THERMAL NEUTRON AND γ-RAY FIELDS. Ikeya, Motoji; Ishibashi, Mitsuo; Itoh, Noriakai (Nagoya Univ., Japan). Health Phys.; 21: No. 3, 429-33(Sep 1971).

Thermoluminescent responses of the mixtures of $CaSO_4$(Mn) and natural and enriched Li_2SO_4 to thermal neutrons and γ rays were studied. The response of $CaSO_4$ (Mn, Li) to γ ray increases slightly and then decreases as the molar fraction, x, of Li_2SO_4 increases. The response to the mixed field increases more prominently than that to the γ ray field as x increases. The dependence of the response on x is analyzed and it is shown that the thermoluminescent response to thermal neutrons is caused by the $^6Li(n,\alpha)^3H$ reaction. The dosimeter $CaSO_4$ (Mn, enriched ^6Li) is found to be about 10 times more sensitive than Harshaw TLD-600 (^6LiF) and is used to separate the γ ray and neutron fields from the mixed field. The ratio of the sensitivity to γ ray, to that to thermal neutrons are found to be 1×10^{-8} rad/n/cm^2 for $CaSO_4$ (Mn, natural Li), and 10.5×10^{-8} rad/n/cm^2 for $CaSO_4$ (Mn, enriched ^6Li). It is suggested that a dosimeter that can give Rem values for the mixed field of γ rays and thermal neutrons can be prepared by adjusting the concentration of ^6Li. (auth) (UK)

51907 VOPROSY DOZIMETRII I ZASHCHITY OT IZLUCHENII. VYPUSK 9. (Problems on Dosimetry and Radiation Protection. Number 9). Kimel, L. R. (ed.). Moscow; Atomizdat (1969). 160p.

A collection of 27 short papers based on work completed up to the middle of 1968 is presented. The subject matter of the papers include radiation dosimetry, spectrometry, radiation protection, radioactive fallout, safety on space flights, and equipment and methods for radiation detection and measurement. (tr-auth)

51908 RADIATION YIELD OF TRIVALENT IRON FROM THE FERROUS SULFATE DOSIMETER EXPOSED TO FAST NEUTRONS. Vasil'ev, A. G.; Viktorov, D. V.; Rozman, I. M.;

Tkachenko, V. V. High Energy Chem. (USSR) (Engl. Transl.); 3: No. 3, 242(May–Jun 1969).

Translated from Khim. Vys. Energ.; 3: No. 3, 269(May–Jun 1969).

The irradiations were carried out using 14.1 ± 0.3 MeV neutrons from the reaction $^3H(d,n)^4He$. The air-saturated dosimetric solution was exposed in glass ampoules (wall thickness 1 mm, internal diam 13 mm, height of liquid 40 mm) placed 80 mm from the neutron source. The integral neutron flux (I, cm^{-2}) was calculated from the measured number of accompanying α-particles (from the activity of the ^{24}Na formed in an organic scintillator containing a known amount of dispersed Al_2O_3). The scintillator, of 13 mm diam and 40 mm height, was placed at the ampoule position. Optical densities (S) were measured before and after irradiation. For a solution thickness $l = 1$ cm and a temperature of 22°C the increment in S was given by $\Delta S = (1.99 \pm 0.13) \cdot 10^{-13} \cdot I$ at a wavelength of 304 nm, and $(4.39 \pm 0.39) \cdot 10^{-13} \cdot I$ at 224 nm. The yield for the reaction $Fe^{2+} \rightarrow Fe^{3+}$ was determined from the equation $G = 6.02 \cdot 10^{22}\, \Delta S(Ql\epsilon)^{-1}$ molecules/100 eV, where ϵ is the extinction coefficient for Fe^{3+} (liter/mole · cm) and Q is the energy (eV) absorbed in 1 cm^3 of solution. In calculating allowance was made for elastic scattering by hydrogen and oxygen and also the reactions (n,n′), (n,α), (n,p), and (n,d) with ^{16}O. It was found that $Q = 4.50 \cdot 10^5 \cdot I$ eV/cm^3; $G = 12.4 \pm 0.7$. (auth)

51909 USE OF DOSIMETRIC FILMS FOR HIGH AND VERY HIGH EXPOSURE MEASUREMENT. **Gazea, F.; Nicolae, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 4, 385-96(1971).**

A method of chemical processing of the dosimetric films which allows the measurable dose range to be extended by two orders of magnitude on commercial dosimetric films currently used is described. The method was applied with good results for the ORWO (3 + 4) and Gevaert dosimetric films, especially in the case of X and γ rays with energies below 200 keV, when the great sensitivity of the photographic emulsion in this range of energy causes a relatively low value of the upper limit dose measurable with dosimetric films. (auth)

51910 POLYMER THERMOELECTRET DOSIMETRY. **Fabel, G. W.; Henisch, H. K. (Pennsylvania State Univ., University Park). Phys. Status Solidi (a); 6: No. 2, 535-41(16 Aug 1971).**

Radiation dosimetry based on thermoelectrets of nylon, mylar, polystyrene, and teflon is described. The effect of storage environment, forming temperature, and forming field strength have been examined for these four materials. The electret polarization was monitored by measuring the surface potential of the electrets by means of a contactless voltmeter probe. The electrets (except those of nylon) were found to be very stable under normal conditions. In the presence of x-ray or thermal neutron radiation, they undergo a rapid and cumulative discharge. The total dosage received can be inferred from a comparison of the initial and residual polarizations. For 50-kV x rays, a dosage of 1 mR is easily detectable by such measurements, and higher sensitivities are believed to be attainable in principle. (auth)

51911 SOLID STATE TRACK RECORDER AS A THERMAL NEUTRON DOSIMETER. **Carfi, N.; Dugnani Lonati, R.; Mangialajo, M. (CISE, Milan). Energ. Nucl. (Milan); 18: No. 6, 360-2(Jun 1971). (CONF-701112).**

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970).

A thermal neutron dosimeter using a fission foil—polycarbonate track detector and a rapid discharge readout system is described. The fission foils used are described, and the calibration procedure is discussed. (W.H.K.)

51912 TITANIUM AS A LUMINESCENCE CENTRE IN THERMOLUMINESCENT LITHIUM FLUORIDE. **Rossiter, M. J.; Rees-Evans, D. B.; Ellis, S. C.; Griffiths, J. M. (National Physical Lab., Teddington, Eng.). J. Phys., D (London); 4: No. 8, 1245-51(Aug 1971).**

Single crystals were grown based on optical-quality lithium fluoride with the addition of magnesium and titanium. The content and distribution of titanium was determined by x-ray fluorescence analysis and related to the intensity of an optical absorption band near 200 nm. The variation of thermoluminescence intensity within each crystal was studied and related to titanium distribution. (auth) (UK)

51913 COMPARISON OF DIFFERENT TECHNIQUES USED FOR ESTIMATION OF INTERMEDIATE NEUTRON DOSE EQUIVALENT. **Gomaa, M. A. (Atomic Energy Establishment, Cairo). Health Phys.; 21: No. 2, 324-5(Aug 1971).**

Two methods of estimating intermediate-neutron dose equivalents are compared. Instruments, calibration methods and equations used for the difference method are described; and assumptions noted. Equations for calculation of the average efficiency and the average intermediate-flux dose-rate-equivalent conversion factor for the Cs-shielded method are given. A table compares results from the two methods for five different positions around the UA-RR-1 reactor. (UK)

51914 USE OF RADIOISOTOPE X-RAY TECHNIQUE IN PHOTOGRAPHIC DOSIMETRY. **Enomoto, Shigemasa; Tominaga, Hiroshi (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo); 8: No. 8, 468-70(Aug 1971).**

The application of radioisotope x-ray fluorescence spectrometry to photographic dosimetry was investigated. An ^{241}Am gamma source, film sample, and Si(Li) detector were used to test the method. The net Ag K_α x-ray count obtained by subtracting the background count due to the film base was proportional to the Ag weight thickness (measured by an optical densitometer) within experimental error. A characteristic curve of x-ray intensity observed vs radiation exposure is given for the badge film. The radiation dose could be extensively observed up to 100 R by this technique. (R.W.R.)

51915 ABSOLUTE DOSIMETRY OF HIGH INTENSITY, 600 kV PULSED ELECTRON ACCELERATOR USED FOR RADIATION CHEMISTRY STUDIES OF GASEOUS SAMPLES. **Willis, C.; Boyd, A. W.; Miller, O. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Radiat. Res.; 46: No. 3, 428-43(Jun 1971).**

Thin adiabatic calorimeters of Be and Al have been used to measure the dose in a cell used for the irradiation of gaseous samples with a Febetron 706 electron accelerator at a dose rate about 2×10^{28} eV $g^{-1}s^{-1}$. By using calorimeters of different thicknesses, the dose at zero thickness was obtained by extrapolation. Electron stopping power corrections were applied to give the dose in N_2O, CO_2, and H_2S. On the basis of this dosimetry, the N_2 yield from N_2O was found to be $G(N_2) = 12.3 \pm 0.3$ in very good agreement with the previously determined absolute value of $G(N_2) = 12.4 \pm 0.3$ at $\sim 10^{27}$ eV $g^{-1}s^{-1}$. The CO yield from CO_2 was found to be $G(CO) = 7.7 \pm 0.2$ and the H_2 yield from H_2S to be $G(H_2) = 13.1 \pm 0.4$. (auth)

51916 AN INSTRUMENT FOR MEASURING SMALL DIFFERENCES IN DOSE RATE AT POINTS IN A RADIATION BEAM. **Naylor, G. P.; Williams, P. C. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Phys. Med. Biol.; 16: No. 3, 525-8(Jul 1971).**

An instrument is described that measures small differences in dose rate between two points in a radiation beam. This system is useful for routine measurements and adjustments to control the field flatness of an x ray beam from a linear accelerator and also for setting accelerator working conditions to produce electron beams with flat fields at energies between 3 and 10 MeV. Two 0.6 cm^3 ionization chambers are used whose sensitivities though made as close as possible need not be exactly equal since the method takes such differences into account. Circuit details and measurement methods are given. (UK)

51917 USE OF COMMERCIALLY AVAILABLE IONIZATION CHAMBERS FOR ABSORBED DOSE CALIBRATIONS OF HIGH ENERGY X-RAYS AND ELECTRON BEAMS. **Almond, P. R.; Jahns, M. F. (Univ. of Texas, Austin. Anderson Hospital and Tumor Inst., Houston, Tex.). Phys. Med. Biol.; 16: No. 3, 497-502(Jul 1971).**

Procedures suggested for using commercially available ion chambers for the calibration of high energy radiotherapy machines were investigated experimentally. Fourteen chambers of three different types were investigated for x-rays of 18.5 and 22 MeV and for electrons in the energy range 6 to 18 MeV. For the x-rays and electrons in the range 9 to 18 MeV, all chambers gave the same calibrations within acceptable limits. For 6 MeV electrons, care must be taken because of the rapidly varying dose field, but for chambers of each type, satisfactory results were obtained. (auth)

51918 MEASUREMENT OF FERRIC ION CONCENTRATION IN THE FRICKE DOSEMETER. 1. **Day, M. J. (Newcastle General Hospital, Eng.); Rasoul, M.; Law, J.; Redpath, A. T. Phys. Med. Biol.; 16: No. 3, 531-3(Jul 1971).**

The implication by Scharf (Phys. Med. Biol. 16:17 Jan. 1971) that Law and Redpath (1968) and Day and Rasoul (1969) did not consider the possibility that the spectrophotometers used might be non-linear in response is refuted in the letters from these authors. The reasons for not laboring the point in the original papers are given. Day and Rasoul also describe the method employed in studying the concentration dependence using potassium nitrate solutions. In his reply to both letters Scharf states that in his paper he pointed out the difference in the evaluation of com-

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parative measurements as suggested by him and that made by Law and his group and did not imply that non-linearity was overlooked by them. It is also suggested that more investigation of the potassium nitrate method should be made, in particular as regards stray light effects, before a definite opinion can be given on its usefulness in ferrous sulphate dosimetery. (UK)

Radiometric Instruments

Refer also to abstracts 51697, 52364, 52440, and 52493.

51919 (AD-721095) DESIGN AND CALIBRATION OF A DEEP OCEAN NUCLEAR PROBE FOR SEDIMENT WATER CONTENT. Final Report, November 1, 1968–May 10, 1970. Ringle, John C.; Bell, J. Richard; Hurley, James L. (Oregon State Univ., Corvallis. Radiation Center). Contract N62399-69-C-0009. 73p. (NCEL-CR-70.016). NTIS.

A laboratory model of a nuclear moisture meter was constructed and calibrated. The meter, which is composed of an Am–Be neutron source and a Cd-covered LiI detector, measures epithermal neutrons. Samples of varying composition and moisture content were assembled and used to determine the accuracy of the meter. The atom-percent-water in any sample was found to vary linearly with epithermal count rate, a result expected and predicted theoretically. These measurements were sediment independent. The moisture content was determined from the atom-percent-water by using porosity. The moisture content was sediment dependent, as expected. The moisture content can be determined over a range of about 20 to 350%. If no information is known about the sediment, the maximum error in moisture content is about 32%; the average error is about 16%. If information is available concerning the sediment (as from a core sample or a gamma density probe), the maximum error in moisture content is about 23%; the average error is about 9%. (auth)

51920 (ORNL-TM-2684) CONTAINMENT INTEGRITY OF ^{226}Ra AND ^{241}Am FOILS EMPLOYED IN SMOKE DETECTORS. Niemeyer, R. G. (Oak Ridge National Lab., Tenn.). 21 Oct 1969. Contract W-7405-eng-26. 19p. Dep. NTIS.

A study was made of the containment integrity of ^{226}Ra and ^{241}Am foils employed in smoke detectors that had been in normal use for 5 to 14 years. Some of the foils were deliberately damaged so that they could be compared with undamaged foils. Contamination of the active surfaces of the undamaged foils averaged 474 and 694 dis/min for the ^{226}Ra and ^{241}Am foils, respectively. Contamination of the damaged foils ranged up to ~300,000 dis/min. Examination of the undamaged foils did not reveal porosity through which the active material could escape to the surroundings. Undamaged foils maintained adequate containment properties when subjected to an environmental test for 12 weeks at 110°F and 80% relative humidity and to a series of 24-hr and 3-week water-leach tests. The average losses for the ^{226}Ra and ^{241}Am foils when subjected to a standard 1-hr fire test were 5.22 and 0.31%, respectively. There were no aging effects observed that would indicate that the foils could not adequately contain the radioactive material, in normal-use environments, for a period of about 50 years. (auth)

51921 DETERMINATION OF THE WEAR OF MACHINE PARTS BY CHARGED-PARTICLE ACTIVATION. Konstantinov, I. O.; Krasnov, N. N. This paper was summarized in At. Energ. (USSR); 29: No. 5, 367-8(Nov 1970) as paper No. 444/5658. (In Russian).

Surface activation by accelerated charged particles can be used to control and determine the wear of machine parts and mechanisms. The studies of the physical characteristics, i.e., the dependence of the yield of fundamental radioactive isotopes on the particle energy and the depth distribution of these isotopes in the active layer, are reviewed. The physical basis and the capabilities of this method are examined. Specific recommendations are offered for the activation of basic structural materials, for measuring their activity, for converting the measured count rate into the size of the layer removed, and for evaluating the error. (auth)

51922 THEORY OF THE GAMMA-RAY TRANSMISSION, DUAL-DISTANCE PRINCIPLE OF DETERMINING THICKNESS. Ely, R. L. Jr. (Research Triangle Inst., Research Triangle Park, N. C.); Gardner, R. P. Nucl. Eng. Des.; 15: No. 3, 237-40(Apr 1971).

Equations are developed for nondestructively determining the thickness of a slab of material of arbitrary composition and density. The equations for determining the accuracy of the principle, the optimum distance between detector positions, and the required source intensities are also developed. For the particular case of measuring the thickness of reinforced concrete pavement a 1.32 millicurie source of 0.662 MeV gamma rays or a 0.782 millicurie source of 1.33 MeV gamma rays is required. This is to obtain a measurements standard deviation of 0.125 in. when a 9-in. thickness is measured with a 1-in. radius by 2-in. thick sodium iodide crystal and when 1-min counting times are employed. (auth)

51923 RADIOISOTOPE VISCOSIMETER FOR MEASUREMENTS OVER WIDE RANGES OF TEMPERATURES AND PRESSURES. Penkina, N. V.; Matsonashvili, B. Ya. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 2, 448-50(Feb 1971).

Translated from Zh. Prikl. Khim.; 44: No. 2, 447-9(Feb 1971).

A radiometric system for measuring the time of fall of a metal load in a liquid is described. The viscosimeter is designed for temperatures up to 350 C and pressures up to 250 atm. (W.H.K.)

51924 MEASUREMENT OF TIME-AVERAGED VOIDS BY NEUTRON DIAGNOSIS. Harms, A. A. (McMaster Univ., Hamilton, Ont.); Lo, S.; Hancox, W. T. J. Appl. Phys.; 42: No. 10, 4080-2(Sep 1971).

Neutron diagnostic considerations have been applied to the determination of void fraction in hydrogeneous media. It has been found that, with the aid of specific definitions for certain neutron-transport parameters, neutron diagnosis offers a greater range of applicability and yields more accurate results than can be obtained by alternative detection techniques. (auth)

51925 TRANSACTIONS OF THE ISOTOPIC SNOW GAGE INFORMATION MEETING, OCTOBER 28, 1970, SUN VALLEY, IDAHO. Boise, Idaho; Idaho Nuclear Energy Commission (1970). 66p. (CONF-701053).

Five papers on isotopic snow gaging and uses of isotopes in hydrology were presented at the conference and are included in this issue. A separate abstract was prepared for each of 4. One paper was not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 51627, 51727, 51926, and 51927.

51926 PROFILING RADIOACTIVE SNOW GAGE. Smith, James L.; Halverson, Howard G.; Jones, Ronald A. (Dept. of Agriculture, Berkeley, Calif.). pp 17-35 of Transactions of the Isotopic Snow Gage Information Meeting. Boise, Idaho; Idaho Nuclear Energy Commission (1970).

From Isotopic snow gage information meeting; Sun Valley, Idaho (28 Oct 1970). See CONF-701053.

The design, operation, calibration, and performance of gamma radiometric profile snow gages are described. The gamma transmission gage measures snow density as a function of depth, snow depth, and water content and melt rate of snow. (W.H.K.)

51927 ENGINEERING THE ISOTOPIC SNOW GAGE. Randolph, P. D. (Idaho Nuclear Corp., Idaho Falls). pp 36-47 of Transactions of the Isotopic Snow Gage Information Meeting. Boise, Idaho; Idaho Nuclear Energy Commission (1970).

From Isotopic snow gage information meeting; Sun Valley, Idaho (28 Oct 1970). See CONF-701053.

Engineering aspects including reliability, accuracy, and cost are discussed for the design of the gamma radiometric snow profile gage. (W.H.K.)

51928 POSSIBILITY TO DETERMINE MEAN PARTICLE SIZE DISTRIBUTION THROUGH QUENCHING EFFECTS. Winkler, K.; Vogt, H. (Zentralinstitut fuer Physikalische Chemie, Berlin). Isotopenpraxis; 7: No. 4, 148-9(Apr 1971). (In German).

Small spheres of lead glass with a radius from 0.2 to 2.55 mm were suspended in a liquid scintillator containing ^{14}C-labeled HCO_2H. Measurements were performed with a 2 channel liquid scintillation counter. Results showed that the shift in pulse height served as a good indicator for particle distribution. (H.B.G.)

51929 STUDIES OF THE SURFACE TYPE GAMMA-RAY BACKSCATTER SOIL DENSITY GAUGES USING COLLIMATION AND SPECTROMETRY TECHNIQUES. McDougall, F. H.; Dunn, W. L.; Gardner, R. P. (North Carolina State Univ., Raleigh). Nucl. Eng. Des.; 16: No. 4, 415-21(1971).

A prototype gage was constructed that allowed evaluation of the effects of energy discrimination and source and detector collimation and collimation angles on gage performance. A NaI(Tl) scintillation detector and a multichannel analyzer were used to provide the energy discrimination capability, and rotatable lead collimators were constructed for collimation purposes. In addition, source–detector separation was varied over a small range. Because of possible competing effects, the different design parameters were varied simultaneously and both single- and dual-gauge results were evaluated. The purpose was to monitor and interpret the effects of energy discrimination and of collimation more than to obtain the best possible design for field applications. The effects on individual errors and on quality factor are displayed and discussed for single gages, and the best dual gages obtained are reported. A triple-gage concept, which would eliminate errors due both to composition variations and to surface roughness, is introduced. (auth)

51930 QUALITY FACTOR CONCEPT FOR EVALUATION OF THE SURFACE TYPE GAMMA-RAY BACKSCATTER SOIL DENSITY GAUGES. Gardner, R. P.; Dunn, W. L.; McDougall, F. H. (North Carolina State Univ., Raleigh). Nucl. Eng. Des.; 16: No. 4, 399-407(1971).

The major sources of error for the surface-type, gamma-ray scatter soil-density gages are identified as sensitivity to soil composition, surface roughness, and counting-rate measurement errors. Methods of measuring these errors are outlined, and a quality factor that properly combines these errors into a single parameter suitable for gage evaluation is proposed. Typical values of these errors and the quality factor are reported for commercial gages. Results are also given for the air-gap ratio method and the air-gap nomograph method. A method for determining the optimum air-gap height based on obtaining the maximum quality factor is demonstrated for a specific commercial gage. (auth)

51931 DESIGN OPTIMIZATION OF THE SURFACE TYPE GAMMA-RAY BACKSCATTER SOIL DENSITY GAUGES USING CONVENTIONAL COMPONENTS WITH THE DUAL-GAUGE PRINCIPLE. Dunn, W. L.; McDougall, F. H.; Gardner, R. P. (North Carolina State Univ., Raleigh). Nucl. Eng. Des.; 16: No. 4, 408-14(1971).

The dual-gage principle was optimized for conventional gage components by varying the four parameters of gamma-ray source energy, source collimation length, source–detector separation, and detector efficiency spectrum in a prototype gage to obtain a maximum quality factor. Quality factors obtained from over 400 dual-gage combinations ranged from 0.019 to 1.344, this range indicating that dual-gage quality is strongly dependent on gage design. The significance of rigid, stable construction to overall gage performance is indicated. Optimum dual-gage designs were achieved with quality factors at least four to five times larger than commercial gages using the air-gap nomograph calibration. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 51362, 51396, 51674, 51712, 52049, 52919, and 54049.

51932 (COO-1422-98) PRELIMINARY REPORT ON A DUAL PHOTON BONE MINERAL MEASURING INSTRUMENT. Sitzman, Jerry C.; Vought, Clifford; Mazess, Richard B. (Wisconsin Univ., Madison. Space Science and Engineering Center). [nd]. Contract AT(11-1)-1422. 3p. Dep. NTIS.

Work accomplished in developing an operating breadboard of a two-channel pulse-height analyzer is described. This breadboard is to serve as a portion of a demonstration model of a proposed Bone Mineral Measuring Instrument system. (auth)

51933 (LA-DC-12378) ELECTRO-OPTICAL PROFILOMETER. Lazarus, M. E.; Romanik, Theodore (Los Alamos Scientific Lab., N. Mex.). [1971]. 11p. (CONF-711008-1). Dep. NTIS.

From 19th conference on remote systems technology; Miami, Fla. (17 Oct 1971).

A system has been built which gives rapid, non-contacting diametrical measurements of irradiated fuel elements as a function of position along the length of the element. The equipment consists of a light source, a system for holding and positioning the element, a periscope, an electro-optical sensor, and a sensor positioning platform. The light source and optics provide an intense, uniform, parallel beam which presents a sharp element shadow, through the periscope, to the electro-optical sensor. The sensor will accurately sense a change of 0.03% of diameter, between 0.125 inch and 1.00 inch diameters at a maximum vertical scan rate of 60 inches per minute. (auth)

51934 (LBL-10) SMALL X-RAY TUBES FOR ENERGY DISPERSIVE ANALYSIS USING SEMICONDUCTOR SPECTROMETERS. Jaklevic, J. M.; Giauque, R. D.; Malone, D. F.; Searles, W. L. (California Univ., Berkeley. Lawrence Radiation Lab.). 16 Jul 1971. Contract W-7405-eng-48. 13p. (CONF-710802-5). Dep. NTIS.

From twentieth annual conference on applications of x-ray analysis; Denver, Colo. (11 Aug 1971).

Fast x-ray fluorescence analysis with radioisotope excitation requires intense sources to produce reasonable counting rates. The inconvenience of handling such sources and the small number of suitable radioisotopes places severe limitations on their use. The possibility of using low-power x-ray tubes as exciting sources for energy-dispersive fluoroscence analysis is discussed. The principal advantage to x-ray tubes is the ability to produce x-ray fluxes to three orders of magnitude higher than those obtained with convenient radioisotope sources while dissipating only a few watts in the tube. Furthermore, the variety of possible anode materials and range of currents in the tube make possible optimum choice of exciting energy and intensity for particular applications. Such tubes have been designed and tested in a variety of anode configurations suitable for fluorescence excitation. Using either x-ray filtering techniques or multiple fluorescence geometries it is possible to significantly reduce the bremsstrahlung background relative to characteristic radiation. (auth)

51935 (UCRL-5093(Pt.2)) COMPUTERIZED FULLY AUTOMATIC ANALYTICAL MASS SPECTROMETER. PART 2: ELECTRONIC DESIGN. Crawford, Richard W.; Stump, Ronald K.; Frazer, Jack W. (California Univ., Livermore. Lawrence Radiation Lab.). 21 May 1971. Contract W-7405-eng-48. 23p. Dep. NTIS.

A time-shared medium size computer has been used to control a fully automated, low resolution analytical mass spectrometer. Major electronic design changes to the spectrometer have been made in the magnet current supply and in the high voltage (accelerating potential) power supply and control. In addition, an inlet valve control for manual or computer operation, a comprehensive vacuum interlock, and a new source-temperature control were built. A commercial electrometer was installed to replace the original one. Digital and analog interfaces to the computer are described. (auth)

51936 (UCRL-73251) IBM PHOTOSTORE AT LRL, LIVERMORE. Boer, Garret L.; Fletcher, John G. (California Univ., Livermore. Lawrence Radiation Lab.). May 1971. 6p. (CONF-710907-1). Dep. NTIS.

From Computer society conference; Boston, Mass. (22 Sep 1971).

The IBM Photostore system at LRL is described; this large-capacity store can hold over 10^{12} bits. (R.W.R.)

51937 VACUUM MICROBALANCE TECHNIQUES. VOLUME 8. Proceedings of the Wakefield Conference, June 12–13, 1969. Czanderna, A. W. (ed.). New York; Plenum Publishing Corporation (1971). 262p. $22.50. (CONF-690662).

A separate abstract was prepared for one of the 18 papers presented. The remaining 17 papers were not within the scope of NSA. (W.H.K.)

For an abstract of an individual paper see: 51938.

51938 THERMAL ANALYSIS SYSTEM FOR RADIOACTIVE MATERIALS. Kerrigan, W. J.; Byrd, J. S.; Holloway, P. D. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. pp 215-27 of Vacuum Microbalance Techniques. Vol. 8. /Czanderna, A. W. (ed.). New York; Plenum Publishing Corp. (1971).

From eighth conference on vacuum microbalance techniques; Wakefield, Mass. (12 Jun 1969). See CONF-690662.

A thermal analysis system is described that provides simultaneous thermogravimetric, derivative thermogravimetric, and effluent gas analyses of radioactive materials. An analytical balance detects weight changes of 20 μg, and a mass spectrometer detects m/e ratios up to 200. The basic equipment is located within a compartmentalized stainless steel glove box that can safely contain gram quantities of compounds of the lower actinides and up to 100 mg of ^{244}Cm. The system is designed for ease of operation and maintenance. Typical thermal analyses of standard and radioactive materials are presented. (auth)

51939 PROCEEDINGS OF THE 24th ANNUAL ISA CONFERENCE, HOUSTON, OCTOBER 27–30, 1969. Advances in Instrumentation, Volume 24, Part 2. Pittsburgh; Instrument Society of America (1969). 223p. (CONF-691004-(Pt.2)).

Separate abstracts were prepared for 4 of the 32 papers presented. The remaining 28 papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 51722, 51952–51954.

51940 PROCEEDINGS OF THE 24th ANNUAL ISA CONFERENCE, HOUSTON, OCTOBER 27–30, 1969. Advances in Instrumentation, Volume 24, Part 4. Pittsburgh; Instrument Society of America (1969). 292p. (CONF-691004-(Pt.4)).

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Separate abstracts were prepared for 5 of the 40 papers presented. The remaining 35 papers were not within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 52047–52049, 52783, and 54254.

51941 NANOSECOND PULSE LIMITER-SHAPER CIRCUIT FOR FAST COINCIDENCE. Samdani, M. G. (Atomic Energy Centre, Dacca, Pakistan). Nucl. Sci. Appl., Ser. B; 5: 33-9 (Oct 1969).

A combined limiter-shaper circuit for negative pulses is described which can deliver delay line shaped bipolar output with subnanosecond rise time. The limiter operates in the current mode and limits at 10 mA output. The circuit is designed to feed a fast coincidence circuit using tunnel diode. It is completely dc coupled and accepts negative pulses at 20 MHz repetition rate. The circuit described here is arranged for 120 ohms cables and 10 mA output. However, with little modification it can be arranged for cables of other standard impedances and any value of output current. (auth)

51942 IMPROVED RATIO RATE METER. Sabol, Jozef; Seda, Josef (Technical Univ., Prague). Rev. Sci. Instrum.; 42: No. 9, 1373-4(Sep 1971).

The principle of the ratio rate meter, which can be realized using simple electronic circuits without special requirements, is as follows: Each pulse of one train (rate n_1) causes the occurrence of one output pulse the width of which is proportional to the inverse value of rate of another pulse train (rate n_2). When bringing the resulting pulse train into an integrator, its reading will be proportional both to n_1 and to $1/n_2$, i.e., to the ratio n_1/n_2. Circuits are presented. (W.H.K.)

51943 METHOD FOR MEASURING THE INCIDENT-BEAM ENERGY IN SCANNING ELECTRON MICROSCOPY USING ELECTRON CHANNELING PATTERNS. Schulson, E. M. (Chalk River Nuclear Labs., Ont.). J. Appl. Phys.; 42: No. 10, 3894-9 (Sep 1971).

Based on recently developed electron-channelling pattern techniques, a method is presented for determining directly the incident-beam energy in scanning electron microscopy. A "standard" crystal is oriented to give a high-resolution pair of electron channelling lines (hkl) and $(\bar{h}\bar{k}\bar{l})$ from a known set of Bragg planes, and from the width of the pair, the Bragg angle is determined using a simple conversion procedure. The De Broglie wavelength of the incident electrons, and hence their energy, can then be calculated. The method is demonstrated experimentally and shown to be accurate to about ±1.5%. This accuracy is possible provided a goniometer tilt stage is available with a tilt accuracy of about ±1% (for example, ±0.02° in 2° tilts), and the effect of scan distortions on the final image is negligible. It is pointed out that the accuracy of lattice parameter measurements using the electron channelling pattern technique could be limited by the accuracy of the incident wavelength. An appendix is given discussing the curvature of channelling lines and the effect of curvature on pair-width measurements. (auth)

51944 DYNAMIC TECHNIQUE FOR MEASURING THERMAL CONDUCTIVITY IN CYLINDRICAL GEOMETRY DESIGNED FOR USE IN RADIATION-DAMAGE STUDIES. Erdman, Carl Arthur. Urbana, Ill.; Univ. of Illinois (1971). 103p. University Microfilms Order No. 71-21,115.

Thesis.

This technique does not require a precise knowledge of either the thermal diffusivity or specific heat of the material under study in order to obtain the thermal conductivity. Moreover, cylindrical specimens are not assumed infinite in the radial dimension. Conductivities may be calculated from a simple relationship between measured heat inputs and temperature differences. The technique could be used as developed with almost no modification in a low-temperature irradiation facility such as that of the Argonne CP-5. Relatively little on-site equipment is required within the reactor cryostat. This is essential due to the small cooling rates typically available (100 watts at very low temperatures in the CP-5). Temperature differences are measured using a phase-sensitive amplifier in conjunction with a mechanical chopper. These combine to produce an extremely sensitive and stable dc amplifier with widely variable response times. The accuracy to which a dc signal can be measured with this system is mainly a function of the stability of the signal. For example, a 0.1-microvolt signal which is stable enough to permit the use of a 1.12-second time constant on the amplifier output can be easily measured to an accuracy of 1 percent. This sensitivity permits the measurement of extremely small temperature differences between thermocouple junctions. Thermal conductivity measurements were made on silicon and aluminum in the temperature range of 100 to 300°K. The mathematical development of the technique is given along with a description of equipment and the results of measurements on silicon and aluminum samples. (Diss. Abstr. Int., B)

51945 MASS SPECTROMETER WITH TRIPLE COLLECTOR FOR HIGH-PRECISION ANALYSIS OF ISOTOPIC STANDARDS OF CARBONS AND OXYGENS. Morales, P.; Gaona, S.; Alba, F. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis.; 19: FA77-90(1970). (In Spanish).

The development of a Nier-type mass spectrometer with a double collector made it possible to measure ^{18}O and ^{13}C in carbon dioxide to an accuracy of ±.01%. Improvements in the instrument make it possible to measure simultaneously the ^{18}O and ^{13}Cu, reducing the time of analysis by one-half. The circuitry to match three vibrating reed amplifiers (Cary Model 31) is described. (auth)

51946 AXIAL BEAM TIME OF FLIGHT MASS SPECTROMETER. Vestal, Marvin L. (to Scientific Research Instruments Corp.). U. S. Patent 3,586,853. 22 Jun 1971. Filed 14 Nov 1968.

A time-of-flight mass spectrometer is described wherein the ionizing electron beam is in axial alignment with the path of the ions produced and wherein an electron multiplier is utilized to generate a high-intensity electron beam for ionization. An open-mesh control grid is utilized to keep the axial dimension of the ionization region very small in order that the distance traveled by each of the ions to an ion detector at the opposite end of a drift tube is very nearly the same. This procedure results in a more accurate measurement of the mass of the ions, since the difference in travel time to reception by the ion detector is primarily because of difference in mass alone and not because of a difference in the distance traveled. (auth)

51947 TIME-TO-PULSE HEIGHT CONVERTER. Bialkowski, Jacek; Karnicki, Wieslaw (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 16: No. 3-4, 169-73(1971).

The principle of operation of the T.P.H.C. is described, and its parameters are specified. Typical plots of differential linearity for the ranges 0.1, 1, and 10 μsec are presented. (auth)

51948 PFR STATION CONTROL AND INSTRUMENTATION. Evans, A. D. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Nucl. Eng. Int.; 16: No. 183, 641-2(Aug 1971).

Selected items of interest are described which either help in the appreciation of overall control and instrumentation problems, or which have novel features arising from the liquid-metal environment or from specific requirements of fast reactors. Amongst the features discussed are the system of collection and presentation of plant data, core monitoring, boiler tube leak detection and sodium flow measurement. (UK)

51949 IMPROVEMENTS IN OR RELATING TO COLD-CATHODE DISCHARGE DEVICES. Maskell, Clifford William Alfred (to United Kingdom Atomic Energy Authority). British Patent 1,238,451. 7 Jul 1971. Filed 18 Jul 1967.

Reference is made to cold-cathode discharge devices forming electron beam sources, such as described in BP 1,154,379 (see NSA 23: 33579). It is sometimes difficult to obtain an elongated beam that may be focussed to give a thin sheet-like beam or to subject an object to a beam over an area that is not circular nor annular, without scanning the beam, and the object of the described improvement is to provide a device capable of giving a beam of non-circular cross section; also to provide a device capable of giving a beam that may be focussed to form an elongated beam. The cathode is cylindrical and an aperture is provided in its wall; the aperture preferably is provided in a position of the wall that is outwardly concave with respect to the cathode. The operating potential applied to the second electrode, positioned in the aperture, may be the same as, or positive or negative relative to, that applied to the cathode. The cathode need not be of right circular cylindrical shape, but may be of any desired cross-sectional shape, for example, it may be of rectangular cross-section. A grounded screening electrode may be provided to surround part of the cathode. (UK)

51950 PROFILOMETER FOR THE DIMENSIONAL INSPECTION OF IRRADIATED FUEL ELEMENTS. Koprowski, B. J.; Donahue, D. A.; Neimark, L. A. (Argonne National Lab., Ill.). pp 174-8 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

A remote controlled profilometer for accurately measuring the diameter of an irradiated fuel element (2-in.-OD, 54-in.-long max) has been constructed and operated in the ANL alpha-gamma hot cell. It features a leadscrew-driven crosshead on which is mounted a gaging unit, i.e., a reference anvil and linear voltage differential transformer (LVDT), in contact with the fuel element. The element is freely suspended and rotated by an independently driven chuck. In operation, the gaging unit traverses the length of the element and provides a continuous trace of deviations in diameter to an accuracy of ±0.0002 in. It is the principal tool for evaluating radiation-induced dimensional changes in LMFBR-type fuel element cladding. (auth)

Radiation Effects on Instruments and Instrument Components

51951 (COO-1624-36) OPTIMUM INITIAL DESIGN CRITERIA FOR THE IMPURITY PROFILES AND GEOMETRIES OF RADIATION HARDENED DIFFUSED SILICON P-N JUNCTION DEVICES. Goben, C. A.; Bereisa, J. Jr.; Irani, C. H.; Han, Y. P. (Missouri Univ., Rolla). [1970]. Contract AT(11-1)-1624. 18p. (CONF-701056-1). Dep. NTIS.

From Microcircuits applications conference; Fort Monmouth, N. J. (Oct 1970).

A computer code for optimizing initial design criteria is developed specifying the fabrication processes (diffusion times, temperatures, concentrations) for radiation tolerant double diffused silicon devices for a-c and d-c operation under the influence of both displacement and ionizing radiation damage. (auth)

51952 NOISE REJECTION IN STRAIN GAGE INSTRUMENTATION. Arlowe, H. D. (Sandia Corp., Albuquerque, N. Mex.). pp 557.1-7 of Proceedings of the 24th Annual ISA Conference. Pittsburgh; Instrument Society of America (1969).

From twenty-fourth annual conference of Instrument Society of America; Houston, Tex. (27 Oct 1969). See CONF-691004-(Pt.2).

The testing of weapons to very fast shock environments very often requires the discharge of high-energy capacitor banks. The discharge of such a capacitor bank generates very large magnetic, electrostatic, and radio frequency fields. These fields can preclude the recording of strain gage data, unless many unusual precautions are taken. How these fields affect the strain-gage circuits is described, and how to arrange the shield strain-gage leads so as to minimize the electrical interference is illustrated. A complete strain-gage signal conditioning system developed at Sandia Corporation is described. Also discussed is the use of a large trailer to minimize noise coupling to the instrumentation and recorders. (auth)

51953 USE OF IRRADIATED SEMICONDUCTOR STRAIN GAGES IN THE PRECISION MEASUREMENT OF LOW-LEVEL STRAINS. Gross, Chris (Langley Research Center, Hampton, Va.). pp 571.1-6 of Proceedings of the 24th Annual ISA Conference. Pittsburgh; Instrument Society of America (1969).

From twenty-fourth annual conference of Instrument Society of America; Houston, Tex. (27 Oct 1969). See CONF-691004-(Pt.2).

Silicon semiconductor strain gages whose thermal coefficient of resistance values have been compensated by subjecting them to high-energy electron radiation have been used in several small-strain applications where low apparent strain and minimization of thermal gradient effects are required. The irradiated gages, because of their low TCR of 0.5% per 55°C, inherently reduce thermal gradient effects. Low apparent strain outputs from full bridges are obtained by matching gages and by selectively annealing one gage of the bridge after bonding. Using these techniques, apparent strain outputs of less than one micro inch per inch over a 55°C temperature interval have been obtained. (auth)

51954 ORIENTATION DEPENDENCE OF THE GAGE FACTOR IN ELECTRON-IRRADIATED SILICON. Littlejohn, M. A. (North Carolina State Univ., Raleigh); Gross, Chris. pp 572.1-7 of Proceedings of the 24th Annual ISA Conference. Pittsburgh; Instrument Society of America (1969).

From twenty-fourth annual conference of Instrument Society of America; Houston, Tex. (27 Oct 1969). See CONF-691004-(Pt.2).

Electron radiation provides a means to compensate (reduce) the TCR and TCGF of silicon strain gages. Further studies of this effect are reported, and, in particular, reports on the orientation dependence of the gage factor of electron-irradiated n-type silicon are discussed. Data are presented for the gage factor versus temperature for different crystal orientations and resistivities. The results indicate that it is possible to choose a crystal orientation (which is not necessarily an axis of high symmetry) such that the TCGF can be further reduced. An analytical model verifies the data presented and lends support to the idea of further reduction of the TCGF of silicon strain gages. (auth)

51955 COMPENSATION OF RADIATION EFFECTS BY CHARGE TRANSPORT IN METAL-NITRIDE/OXIDE/SEMICONDUCTOR STRUCTURES. Cricchi, J. R.; Barbe, D. F. (Westinghouse Advanced Tech. Labs., Baltimore). Appl. Phys. Lett.; 19: No. 3, 49-51(1 Aug 1971).

The effects of ionizing radiation on complementary metal/nitride/oxide/silicon (CMNOS) structures for oxide thicknesses in the range 20–50 Å are considered. The bidirectional radiation-induced threshold-voltage shifts in CMNOS structures are interpreted in terms of charge accumulation at the nitride/oxide interface. The electronic recovery of preirradiation threshold-voltage levels by carrier transport through the thin oxide is shown experimentally. (auth)

51956 CHANGES IN THE VOLT-AMPERE CHARACTERISTICS OF BLACK SILICON CARBIDE VARISTORS SUBJECTED TO FAST NEUTRONS. Ribarov, S. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 24: No. 2, 159-62(1971). (In Russian).

Black silicon carbide with graphite electrodes were irradiated at 40 to 50°C in a nuclear reactor with fast neutrons (2.8×10^{11} n/cm^2 · sec). The total dose varied from 1.68×10^{14} to 1.04×10^{16} n/cm^2 in different experiments. With increasing radiation dose the current passed at a given voltage decreased until at the upper dose limit the current was reduced to less than half of that passed by a control sample. (K.S.W.)

51957 RECENT DEVELOPMENTS IN RADIATION HARDENING SILICON SOLAR CELLS. Wolf, M. (Univ. of Pennsylvania, Philadelphia); Brucker, G. J. Energy Convers.; 11: No. 3, 75-90(Sep 1971).

It was established that lithium can move about rather freely in silicon, and that it complexes with radiation damage centers in such a way as to neutralize their performance-degrading effect. Significant numbers of experimental lithium containing solar cells have now been prepared with initial efficiencies equal to or better than those obtained on standard production "n on p" 10 Ω cm solar cells. The lithium containing cells showed, after bombardment with 1 MeV electrons and recovery, a power output slightly higher than that of the "n on p" cells. More striking is the advantage of the lithium containing cells under heavy particle bombardment. After recovery from 17 MeV proton or from energetic neutron irradiation, the lithium cells match the power output of standard "n on p" cells having received an approximately 30 times smaller radiation dose. Lithium containing solar cells can exhibit degradation, both before irradition and after recovery. A remedy against this instability was thought to be in the simultaneous introduction of oxygen. The oxygen-rich cells recover much more slowly from radiation damage than the oxygen free cells: over several months compared to several days. Oxygen-lean lithium containing cells, however, were found to be stable after an initial "recovery overshoot", if fabricated by appropriate methods. Interesting findings were made relative to solar cell performance in low temperature environments. The solar cell efficiency is approximately 50% higher, and the introduction rate of defects due to particle bombardment is lower than at room temperature. Nevertheless, the radiation damage was found to be enhanced both by a shift in the absorption curve of the semiconductor and a shift in the Fermi-level. The low solar intensity near Jupiter further enhances the latter effect. While lithium is ineffective at this low temperature, the "p on n" structure was found to incur less damage from proton bombardment than the "n on p" type. By use of lithium containing cells, solar flare damage—experienced primarily during the early part of the mission—can be eliminated by annealing since the cells are still at high temperatures where the lithium is effective. The micrometeorite belt is now thought to have negligible effect on the solar cells and on their covers. (auth) (UK)

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LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 53752.

Basic Processes

Refer also to abstracts 52017, 52019, 52121, 52122, and 52279.

51958 (A/CONF.49/P–404) INVESTIGATIONS ON THE FATE OF CERTAIN PESTICIDES UNDER BIOTIC AND ABIOTIC CONDITIONS USING TRACER TECHNIQUES. Korte, F.; Klein, W.; Suss, A.; Siegmund, H. Apr 1971. 22p. (CONF-710901–144). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Measurable concentrations of a number of pesticides are present in plants, soil, animals, and man. Therefore, it is of utmost importance to know the fate of these compounds in the biosphere. Since metabolites and environmental conversion products can be more persistent than the parent compounds and can also have biological activities differing from those of the parent compound, efforts should be concentrated on investigating the most persistent products, no matter whether parent compounds or environmental conversion products are concerned. The impact of a substance on the environment, be it a parent compound or a breakdown product, is determined by the amount of the parent compound used, by the biological effects of the chemical concerned, and its persistence. The rhythm of use of the pesticide in terms of its function time must always be considered. Therefore the function time rhythm of a pesticide must take into consideration not only its biological half-life, but also its presence afterwards in terms of any residual terminal chemical definition. Abiotic reactions of organochlorine compounds in the environment are mainly photoisomerizations or photodechlorinations, as far as is known today. The ^{14}C-labeled compounds (monolinuron, pyrazon, and simazine) were used to study the degradation of herbicides in different soils. By measuring the formed $^{14}CO_2$, the characteristics of breakdown were established. (auth)

51959 (A/CONF.49/P–563) USE OF RADIOISOTOPES IN BIOMEDICAL RESEARCH. Pecorini, V.; Degrossi, O. J.; Altschuler, N.; Capalbo, E. E. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). May 1971. 24p. (In Spanish). (CONF-710901–493). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Medical investigations with radioisotopes are being conducted along four basic lines: dynamic studies; kinetic studies; development of scanning techniques; and in vitro techniques. Among the dynamic studies are investigations on peripheral and brain circulation, coronary flux, and lung circulation using gamma cameras and auxiliary memories. The kinetic studies include studies of electrolytes (iodine and calcium), labeled proteic hormones (thyroxine, triiodothyronine, growth hormone, and thyrotropin), iron, and vitamin B_{12}. Scanning techniques with short-lived radioisotopes employing conventional scanners and gamma cameras are used for the detection of tumors. The in vitro studies center around the quantitative determination of hormones in different biological samples by means of saturation techniques (binding capacity of thyroid hormones to serum proteins), competition techniques (thyroxine and cortisol), and radioimmunoassay (insulin and growth hormone). In nuclear biochemistry, the following lines of research are in progress: the role of cyclic nucleotides in hormone regulation using labeled precursors; in vivo and in vitro studies at the subcellular level on the mechanism of action of several hormones using chromatography, density gradient, and radioisotopes (^{131}I, ^{125}I, and ^{32}P); studies on the regulation of protein biosynthesis using labeled precursors; the determination of enzymatic activities in human pathology using radioiodine, spectrophotometry, and chromatography; and the dosage of proteic hormones using radioimmunoassay. Investigations in radioimmunology include: characterization of the antibody responsible for rejection of allogenic crafts and its origin; techniques for the quantitation of antibodies; the in vitro effects of x rays on immunocompetent cells and their recovery following sublethal doses; the radiosensitivity of cells actively engaged in the rejection of allogenic grafts; the cellular evolution of thymuses implanted in diffusion chambers; and tumor immunity, immune tolerance, and autoantibodies in thyroid patients treated with ^{131}I. (E.R.B.)

51960 (A/CONF.49/P–626) NUCLEAR METHODS TO INCREASE FOOD PRODUCTION. NUCLEAR TECHNIQUES APPLIED TO THE WATER CYCLE IN AGRONOMY: PRESENT SITUATION AND PROSPECTS. Couchat, P. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). May 1971. 15p. (In French). (CONF-710901–257). Dep NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

An account is given of theoretical and experimental studies showing the respective advantages, for neutronic moisture measurements, of the thermal, epithermal and fast flux zones. Standard surface and depth moisture-meters use the thermal zone and, provided a specific calibration of the soil is made, the data collected by an entirely automatic system are computer-analysed. Epithermal flux detection and fast neutron spectrometry open up new possibilities in combination with gamma radiation absorption techniques. The isotopes ^{3}H or ^{18}O, used in preference to ^{131}I to label water, are the essential complements of radiation to define the movement of water towards and through the roots, the drainage component of soils, and the extent of capillary absorption. To conclude, it is by the combination of conventional techniques, tensiometers for example, and nuclear techniques, together with the use of digital computer methods that the agronomist can expect to obtain information on the dynamics, origin, and destiny of water. (auth)

51961 (A/CONF.49/P–669) USE OF RADIOISOTOPES AND RADIATION IN AGRICULTURE IN SOUTH AFRICA. Haasbroek, F. J. (Fruit and Food Technology Research Inst., Stellenbosch, S. Africa). May 1971. 20p. (CONF-710901–315). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A review is presented of radioisotope studies in agriculture in South Africa during the past decade. It includes a discussion of the relative importance of factors, such as the method of incorporation of ^{32}P into the soil, carrier P concentration, radiation effects, and corrections for seed P when using the L-value technique for the determination of labile soil P. Results obtained in comparing different phosphatic fertilizers, with special reference to rock phosphate, and factors affecting the determination of exchangeable and labile calcium in different soil types, are discussed. Other studies discussed include plant physiological/biochemical investigations, use of labeled pollen techniques to follow tube development, and also some animal studies, such as the use of tritium for the determination of total body water of ruminants. (E.R.B.)

51962 (A/CONF.49/P–694) APPLICATION OF NUCLEAR RADIATIONS IN INVESTIGATIONS ON PLANT PHYSIOLOGY IN UKRAINIAN SSR. Vlasyuk, P. A.; Grodzinskii, D. M. (Akademiya Nauk Ukrainskoi SSR). May 1971. 18p. (In Russian). (CONF-710901–496). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In the Ukrainian SSR, tracer methods are now widely used in investigations of plant metabolism and nutrition. This has led to revealing the nature of some physiological and biological processes and the development of a number of methods that provide a stimulating action on the plant organism; increase plant productive capacity. At the Institute of Plant Physiology (the Acad. of Sci., Ukr. SSR) it was possible, with the help of trace elements, to show differences in the utilization of some microelements and major elements of nutrition, in dependence on fertilizer forms, and in methods of their application. Using the methods of isotope dilution, the rate of repeated utilization of such nutrition elements as phosphorus, sulphur, and calcium was calculated. With the help of various metabolites of radiocarbon labeled in different positions, the grade difference of winter wheat and sugar beet metabolism was studied in connection with the type of plant productive capacity. It was also shown that heterogeneity of metabolic stock in amino acids, carbohydrates, phosphorus ethers, orthophosphate, and other compounds plays an important role in the biochemical situation occurring in cells and in determining the character of accumulation of any substances. In connection with this study, the problem of intracellular metabolism is being examined in detail. Investigations were conducted to determine the rate of isotopic tag incorporation into the substances of individual structural components of the cell, of metabolite exchange between chloroplasts and cytoplasm, and the rate of assimilate transport. Nuclear radiation, as an experimental form-producing factor for farm plants, has an increasing use in the selection process. New forms of plants with good properties are obtained in the experimental selection stations of the Uk. SSR with the help of radioinduced mutagenesis. These plants include lupin which is characterized by a high productive capacity and a peculiar bush form and makhorka without sideshoots in the process of its growth, which makes its cultivation more cheap. New forms of hop, buckwheat, and potatoes were produced that have great potential for selection. The development of radiobiological research for plants made possible the use of radioprotectors and factors modifying the radiation reaction thereby increasing the permissible doses for radioinduced mutagenesis and for the solution of some other problems in plant production. (auth)

51963 (NYO-3778-13) ACTIVATION ANALYSIS IN RESEARCH AND FORENSIC MEDICINE. **Progress Report V, May 1, 1970–June 30, 1971. Maletskos, Constantine J. (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.). Contract AT(30-1)-3778. 82p. Dep. NTIS.**

All efforts to date were combined and applied to the investigation of a specific patient at the New England Deaconess Hospital who had large quantities of iron stores. This case was used as an opportunity to test our methods, overall and quantitatively, on malignant and normal tissue and on the iron binding protein, ferritin. Some quantitative results are presented. It was observed that each tissue has its own problems and that a survey of such human tissues is useful to delineate these problems. Some spectra from the beginning of such a survey are shown. As another aspect of our investigation of sample types, preliminary results are shown on particulate analysis of Boston's atmosphere, on marine samples, and on contaminants in reactor coolant water to show the wide applicability of the removal methods for radioactive interferences. In regard to tissue handling, the results on possible contamination by various preparatory methods were compared by a semiquantitative approach. Variations by a factor of 2 to 3 were discerned, but the common denominator of biological variability between adjacent pieces of tissue must still be determined against which the results of the various methods must be eventually compared. Resolution limitations with our present Ge(Li) detector system preclude a fully quantitative analysis. An investigation of elemental losses during the freeze-drying step of tissue preparation was made, and of the nine elements studied only Se showed a loss of up to 4%. (Hg was specifically omitted). The study of some of the basic mechanisms of the isotopic exchange procedure for the removal of radioactive interferences has continued. These include such aspects as the solubility of salts in acetone and acetone-water mixtures and the behavior of salts in acetone-water mixtures. Some further details of the retention of Cl and Br in the salt columns were pursued. The selectivity of the ^{32}P removal procedure with adsorption alumina was investigated for those elements that are retained in varying amounts on the columns. Water, rather than any other solvent studied, will elute them quantitatively. A comparison between our removal method for Na and Girardi's methods indicates that our method is more selective. While more basic studies are required, the removal methods are now at a point where they can be applied to specific problems involving biological materials. Our competence in data processing and analysis is essentially under control now. The work on the use of enriched stable ^{41}K was delayed because the quantitative removal of ^{42}K from irradiated serum is compromised by the removal of some ^{24}Na arising from the natural contamination of the KCl salt with Na. This problem was solved by the use of NaCl in conditioning the KCl columns and during elution to reduce the ^{24}Na contamination in the ^{42}K retained on the column. This is done without significant sacrifice to the retention of the ^{42}K. Preliminary results with the use of Cr salts to isolate ^{51}Cr from irradiated sera containing enriched stable ^{50}Cr indicate that the solution will not be easy and that a detailed study will be necessary since one has to work with the natural physical and chemical properties of the salts as they occur. Finally, an irradiation facility using ^{252}Cf is described for the irradiation of samples and small living animals in a flux of about 10^9 slow neutrons/cm^2 · sec. The main features are economy, simplicity, safety and flexibility, and the ability to turn this essentially small pool reactor "on" and "off." (auth)

51964 IMPROVED METHOD OF PACEMAKER ROENTGENOGRAPHY. **Short, Welland F. (Univ. of Pittsburgh); Schloss, John; Morse, Dryden P. Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 3, 571-3(Jul 1971).**

The roentgenographic study of cardiac pacemakers for signs of battery depletion is a valuable method of estimating pacemaker life expectancy. However, properly positioned and exposed roentgenograms (with the roentgen-ray beam directed perpendicular to the long axis of the batteries) are necessary for satisfactory evaluation. A new (fluoroscopic) compression cone is described which, when used as advised, has greatly simplified this procedure. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 51711, 52014, 52125, and 52278.

51965 (A/CONF.49/P-147) RADIOBIOLOGICAL STUDIES AND AVAILABILITY OF RADIOPHARMACEUTICALS FOR MEDICAL APPLICATIONS IN U.A.R. **Hashish, S. E.; Roushdy, H. M.; Abdel-Wahab, M. F.; (and others) (Atomic Energy Establishment, Cairo (Egypt)). May 1971. 18p. (CONF-710901-84). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Recent development in nuclear technology stimulated research in radiobiology to ensure safe use of nuclear energy with respect to man and other living organisms. In this study, animals were subjected to gamma and beta radiation and the biological effects were evaluated. Attempts have been made to control such effects by chemical radiation protectors. Efforts were also made to investigate the degradation effect of different types of ionizing radiations on vitamin C and riboflavin content of legumes and gramineae seeds irradiated during germination. The degradation products were separated and evaluated under each condition. The U.A.R. Radioisotope Production Laboratory is covering all the increasing demands for radioisotopes and labelled compounds for medical applications. Efforts have been made to widen the distribution of milking systems for rapid provision of short-lived radioisotopes and for direct labelling of large molecules. Developmental research permitted the preparation of new pharmaceuticals and organic compounds labelled with ^{99m}Tc, ^{131}I, ^{197}Hg, ^{203}Hg, ^{115m}In and ^{14}C. The techniques adopted for preparation and radiopharmaceutical control are discussed. Three common endemic diseases; protein-calorie malnutrition, bilharziasis and dyshormonogenetic goitre have been investigated using diagnostic tracer studies. Children suffering from five different cases of malnourishment have been tested for haematological levels, ferrokinetics and body water compartment using IHSA-^{131}I, ^{59}Fe, and ^{3}H. Bilharzial patients showing different stages of disease complications have been tested for liver function test, collateral circulation using labelled macromolecules, haematological levels, W. B. C. survival, platelet life span and rate of vitamin B_{12} absorption using ^{59}Fe, DF^{32}P and vitamin B_{12}-^{57}Co respectively. A series of labelled antimonial drugs has been synthetically prepared for therapy, and investigated. A survey of endemic goitre has been made using ^{131}I, ^{99m}Tc, and their labelled molecules T_3 and T_4. Simple laboratory techniques have been adopted for in vivo and in vitro preparation of some labelled large molecules used in medical research. (auth)

51966 (A/CONF.49/P-506) TRACER STUDIES OF THE ROOT SYSTEMS OF CROP PLANTS. **Russell, R. Scott; Clarkson, D. T. (Agricultural Research Council, Wantage (England). Letcombe Lab.); Newbould, P. (Hill Farming Research Organisation, Edinburgh (Scotland)). May 1971. 12p. (CONF-710901-225). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The complex branching of plant root systems and their concealment in soil make them perhaps the most inconvenient of plant organs for detailed study but tracer methods, some of which are discussed in this paper, now facilitate research on their physiology and interaction with soil. Relationships between the morphology of different parts of root systems and their ability to contribute to the nutrition of the whole plant can be studied, in solution culture, by the localised application of labelled nutrients to zones of roots which are enclosed in suitably designed cells. Nutrients contrast in the relative extent to which they are absorbed by different parts of root systems. Some, for example potassium and phosphate, enter all parts of the roots of cereal plants 2-3 weeks old; transfer to the stele is not prevented by the thickening of the endodermis in the older zones. Microradioautographs and electron micrographs assist in interpreting these observations. In field experiments, on crops grown under normal agricultural conditions, the absorption of nutrients from different depths in soil can be examined by injecting tracers in selected positions and measuring the radioactivity which reaches shoots. Moreover the distribution of living roots can be studied by injecting rubidium-86 into shoots; it moves sufficiently uniformly to roots for their distribution to be shown by measurements of

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radioactivity in the soil. The use of these procedures is illustrated by investigations carried out, in collaboration with other Agricultural Research Institutes in England, on the effects of reduced cultivation on root growth in cereals and on root development in different varieties of cereals. Reduced cultivation holds promise of considerable economy in production costs while information on the effects of genetically controlled variation in root structure may assist in the selection of new varieties. (auth)

51967 (A/CONF.49/P–756) FIRST TWENTY YEARS OF WORK ON RADIOISOTOPES IN LATIN AMERICAN AGRICULTURE. Bornemisza, E.; Malavolta, E. (Inter-American Nuclear Energy Commission, Washington, D. C.). May 1971. 16p. (In Spanish). (CONF-710901–508). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Approximately five years after radioisotopes became available, they started to be used in agriculture in Puerto Rico for studies on phosphorus fertilizers. The technique spread slowly. The next experiments were carried out in the Centro de Energía Nuclear en Agricultura de Piracicaba, Brazil. The second half of the decade saw the expansion of the technique to centers in Argentina, Colombia, Chile and Costa Rica, partly as a result of the First Inter-American Symposium on the Peaceful Use of Nuclear Energy, held in 1956. Most of the work was oriented toward phosphorus problems in soils and plants, and experiments on fertilizer techniques were conducted in a number of countries. Another important field where work has been proceeding for more than a decade is the field of micronutrients. In addition to soil studies, research has also been conducted in plant and animal physiology, particularly with regard to mineral nutrition. Several irradiators using ^{60}Co and ^{137}Cs have also been installed to produce artificial mutations, and their use has contributed appreciably to knowledge of the genetic mechanisms of a number of important plants. Irradiators are also being intensively employed to combat insects, using the sterile male technique. Particularly promising results have been achieved in combating the Mediterranean fruit fly, for example in Peru. Basic studies have also been carried out in Brazil on the control of various insects that attack stored grains (beans and corn). In recent years, studies have also been initiated on the movement of water in soil and in underground deposits. The most important work in this field has been carried out in Argentina, Brazil, Chile and Puerto Rico. In Brazil, work has also begun on the isotopic variation of H and O to determine the age and size of water deposits, in addition to their movements. Food irradiation has received some attention both in Brazil and Colombia, as has the production of mutagenic agents. Notwithstanding the progress made in the above experiments, there is need for a much more intensive use of the technique of radioactive or heavy tracers in our countries. (auth)

51968 (CONF-710428–, Paper 5) SUCCESSFUL USES OF RADIATION IN AGRICULTURE. Cromroy, Harvey L. (Florida Univ., Gainesville). 30p.

From Conference on innovative applications of radiation; Dallas, Tex. (22 Apr 1971).

In Conference on innovative applications of radiation.

Uses of radiation in agriculture reviewed include: the use of radioisotopes as tracers in studies of plant growth, especially for studies on metabolism and translocation; the use of radioisotopes as tracers for metabolic studies on domestic animals; the use of radioisotopes as tracers in studies of insect ecology; the use of radiation (γ and x) to produce mutations for plant breeding programs; the use of nuclear meters for measurements of soil moisture content and soil density; uses of ionizing radiation for processing foods to extend the storage life; and the use of ionizing radiations for the control of insect populations. A list of 75 insects under study for eradication by the release of radiosterilized males (sterile male technique) is included. (C.H.)

51969 (CONF-711001–(Vol.2), pp 551-9) METABOLISM OF MONOMERIC AND POLYMERIC PLUTONIUM IN SMALL ANIMALS: RADIOTOXIC IMPLICATIONS FOR MAN. Lindenbaum, Arthur (Argonne National Lab., Ill.). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

A brief review is presented of some of the metabolic studies carried out with small animals (mice and rabbits) at Argonne over the past decade or so, particularly those with results having implications for the ultimate animal, man. The objective is to develop therapeutic procedures for the removal of bone-seeking radionuclides from the body, principally the alpha-emitting actinides. Consequently, this discussion will be confined mainly to plutonium-239, for which 0.6 micrograms is the allowable maximum permitted to accumulate in a human skeleton without fear of radiological effects. A description is given of those characteristics of plutonium which are prototypical (at least qualitatively) of the actinide and rare earth elements in living tissues and which distinguish them from the monovalent metals and from other multivalent metallic elements (the alkaline earths) which are also "bone seekers." (D.L.C.)

51970 (NIRS-Pu–6) RESEARCH REPORT ON INTERNAL EXPOSURE DUE TO PLUTONIUM IN APRIL 1968–MARCH 1969. (National Inst. of Radiological Sciences, Chiba (Japan)). Oct 1969. 81p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Results are reported from studies on the radiation dose from interstitial Pu performed during fiscal 1968. Data are included on: inhalation of plutonium compounds and the injuries therefrom; plutonium deposition in the lungs; peculiar metabolism of plutonium; internal-exposure effects of plutonium; personnel protection in a laboratory where alpha-emitters are used; emergency measures for plutonium-handling personnel; and injuries from plutonium. The research results are presented in individual reports, namely: The characteristics of respiratory system of rats studied using radioactive aerosols; The development of plutonium aerosol inhalation apparatus; Distribution and excretion of inhaled Eu by rats as applied for an activable tracer; The development of a plutonium lung monitor using a thin NaI(Tl) crystal of large area; The development of a large area proportional counter for assessment of plutonium lung burden; The development of a human lung phantom for plutonium monitoring; Statistical errors in plutonium air monitoring; Plutonium excretion into bile and its acceleration by cholagogues; The mechanism of selective uptake of particle in organs; Effect of ^{239}Pu alpha particle irradiation on reticuloendothelial function in mice; Whole-body autoradiographic study of the distribution of plutonium following administration by different routes; Ultra-high speed radioautography to determine the activity of plutonium particles; Experiments on continuous flocculation for the treatment of radioactive effluent; A method for the bioassay of plutonium contamination; The development of a lung counter for a rat; and The development of a portable plutonium wound monitor. (Japan)

51971 (STI/PUB–293) MINERAL STUDIES WITH ISOTOPES IN DOMESTIC ANIMALS. Panel Proceedings Series. Proceedings of a Panel Held in Vienna, 28 September–2 October 1970. (International Atomic Energy Agency, Vienna (Austria)). May 1971. 203p. (CONF-700966). IAEA $6.00.

Separate abstracts were prepared for nine papers presented at the conference. An additional nine papers are included on various aspects of mineral metabolism in domestic animals. (H.L.W.)

For abstracts of individual papers see: 51980–51986, 52142, and 52210.

51972 (UCLA–12–831) BILIARY EXCRETION OF ^{99m}Tc ALBUMIN MICROAGGREGATE DEGRADATION PRODUCTS (A METHOD FOR MEASURING KUPFFER CELL DIGESTIVE FUNCTION). Kitani, Kenichi; Taplin, George V. (Los Angeles County Harbor General Hospital, Torrance, Calif. Nuclear Medicine Div. California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1971]. Contract AT(04-1)-Gen-12. 21p. Dep. NTIS.

The present study was designed to learn more about the biliary excretion of ^{99m}Tc following albumin microaggregate injection and to determine whether its rate and amount of excretion could be used to estimate a proteolytic digestive function of the liver's Kupffer cells. The direct observation, via scintillation camera imaging, of the hepatobiliary excretion of a ^{99m}Tc compound, most probably an albumin degradation product, following the intravenous injection of ^{99m}Tc albumin in particulate form (1 to 5 μ microaggregates) is described. This finding has provided the first objective, practical, and potentially useful clinical method to estimate a proteolytic digestive function of the liver's Kupffer cells separately as opposed to those of the entire RES. (E.R.B.)

51973 (UR–49–1496) MOBILIZATION, RETENTION, AND EXCRETION OF ^{181}W IN THE BEAGLE FOLLOWING INJECTION OF $Na_2{}^{181}WO_4$ AND INHALATION OF $^{181}WO_3$. Aamodt, Roger Louis (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). 1971. 100p. Dep. NTIS.

Thesis.

The metabolism of injected sodium 181-tungstate and inhaled 181-tungstic oxide was studied in beagle dogs. Sodium tungstate injection solution was prepared from $^{181}W^{vi}$ in 0.5N HCl and 0.1N HF, by conversion to $^{181}WO_3$ followed by fusion with sodium carbonate. The inhalation aerosol was generated from a solution of K_2WO_4 which was converted to tungstic acid. The tungstic acid in aqueous suspension was nebulized to produce an aerosol and then converted to tungstic oxide by passage through a tube furnace heated to 800°C. The resulting aerosol had an activity median aerodynamic diameter of .75 μ with an average geometric standard deviation of .21 μ. The dose given to the injection dogs was 1.5 to 2.3 μCi injected intravenously in the cephalic vein. The inhalation dogs received a deposited dose of 1.9 to 8.0 μCi by nose-only inhalation. Whole-body measurements and partial body measurements were made using the 59 keV K x-ray of tungsten-181. Two partial-body measurements were made, one called lung position was made over the thorax, while the other (visceral position) was made over the posterior portion of the dogs body. The dogs were confined in a lucite tube and placed between two 8″ × 1″ thin aluminum window (5 mil) sodium iodide (Tl) scintillation crystals connected to a 512 channel pulse height analyzer. Urine and fecal samples were collected in metabolism cages. Blood samples were taken by venous-puncture of the external jugular veins until activity in the blood had decreased below the limit of detection of the counter. Data on tissue distribution and excretion are included. (C.H.)

51974 FLUX RATIOS AND ISOTOPE INTERACTION IN AN ION EXCHANGE MEMBRANE. DeSousa, R. C.; Li, J. H.; Essig, A. (New England Medical Center Hospitals, Boston. Tufts Univ., Boston). Nature (London); 231: 44-5(7 May 1971).

It is pointed out that there is a considerable discrepancy between permeability coefficients derived from tracer exchange in studies of permeation in biological tissues and those derived from net flow of fluids in such tissues. There is also ambiguity in the use of the "flux ratio" to evaluate forces promoting transport, and abnormal flux ratios have frequently been observed. Although these difficulties have been appreciated, and explained in mechanistic terms, there has been no unifying treatment. Kedem and Essig (J. Gen. Physiol., 48: 1947(1965)) suggested that the anomalies can be attributed to coupling between the flows of the abundant and tracer species ("isotope interaction"). This, however, has not been tested experimentally. Some experiments are described with collodion membranes activated with quaternary ammonium polyelectrolytes, which showed tracer exchange rates greater than predicted from their electrical resistance, the membranes were exposed at each surface to 0.1 MKCl. Unidirectional fluxes were evaluated from two series of measurements of tracer flow, one with and one against the electrical potential gradient. The results substantiated a thermodynamic treatment and supported the view that anomalous tracer permeability coefficients and flux ratios are due to coupling of isotope flows. In biological membranes exchange diffusion by means of mobile carriers is usually invoked, but it was considered unlikely that carriers could traverse the synthetic membranes used in the studies described, suggesting that such carriers may not be the mechanism for abnormal flux ratios in biological membranes. (UK)

51975 POTASSIUM AND ^{137}Cs CALIBRATIONS OF THE EXPERIMENTAL WHOLE-BODY COUNTER OF THE STATE-CENTRE OF RADIATION PROTECTION OF THE GDR. Poulheim, K.-F. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Radiobiol.-Radiother.; 11: No. 6, 713-28(1970). (In German).

Methods used for the calibration of the experimental whole-body counter of the State-Centre of Radiation Protection are described in detail. The time of occurrence of the uniform distribution of ^{42}K in the body, as well as the dependence of the calibration factors on the structure of the body of the persons were determined. Comparisons with different phantom calibrations were made. Cesium-137 calibration with a simple, easily assembled human phantom is described. An international comparison of the determination of K-content and ^{137}Cs content of several persons was performed for checking the calibration. (auth)

51976 METABOLISM OF INHALED RADIOSAMARIUM IN MICE. Gensicke, F.; Nitschke, H.-W. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Radiobiol.-Radiother.; 11: No. 1, 57-61(1970). (In German).

The metabolism of samarium after inhalation of $^{153}SmCl_3$ was examined in mice. The resorption from the lung was slow and led to incorporation into the skeleton. The retention resembled that of radiosamarium after subcutaneous application. (auth)

51977 METABOLISM OF ^{95}Nb AFTER PARENTERAL ADMINISTRATION OF ^{95}Nb OXALATE IN MICE. Gensicke, F.; Nitschke, H.-W. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Radiobiol.-Radiother.; 11: No. 1, 63-72(1970). (In German).

The metabolism of ^{95}Nb-oxalate in mice was examined after parenteral administration and the effects of several decorporative agents were tested. The preferred organs of accumulation were the liver and the skeleton. Clearance mechanisms in the blood and in the whole-body are discussed in detail and the respective constants are given. The results are compared with those after inhalation of fluid aerosols of ^{95}Nb-oxalate. (auth)

51978 RADIOACTIVITY LEVELS IN THE MOUSE ORGANS FOLLOWING ADMINISTRATION OF TRITIATED 2-METHYL-PIPERAZINE DITHIOFORMATE, A NEW RADIOPROTECTOR. Vertua, R.; Furlani, A. (Univ., Trieste, Italy). Arzneim.-Forsch.; 21: No. 4, 551-3(1971).

The tissue distribution of radioactivity, at various times (10-, 30-, 60-, 180-, 360-min and 24 hr after the intraperitoneal (i.p.) administration of a labeled radioprotector of the liver 2-methyl-piperazine-dithioformate (DTP), was studied. Blood radioactivity was found to increase up to 60 min, then there was a plateau until 180 min followed by a slow decrease. Radioactivity was present in all tissues studied in virtually uniform amounts. Appreciable amounts of radioactivity were found in the blood and tissues also after 24 hr. The percentage of the injected radioactivity was also followed. It was concluded that the drug, administered i.p., was rapidly distributed in the body, while its metabolism was markedly protracted. (auth)

51979 DISTRIBUTION OF ^{75}Se-SELENOMETHIONINE AS INFLUENCED BY THE ROUTE OF ADMINISTRATION. Graham, Leonard A.; Veatch, Roger L.; Kaplan, Ervin (Veterans Administration Hospital, Hines, Ill. Loyola Univ., Chicago. Univ. of Illinois, Chicago). J. Nucl. Med.; 12: No. 8, 566-9(Aug 1971).

Organ distribution data were obtained for rats following the administration of ^{75}Se-selenomethionine in trace quantities by the intravenous, oral, subcutaneous, and intraperitoneal routes. The tissue distribution and the concentration of isotope were similar except shortly after administration when high concentrations were present at the site of administration. The addition of carrier methionine had little effect on the concentration and distribution of ^{75}Se-selenomethionine. A reduction of more than 50% was observed in the plasma following the addition of carrier selenomethionine. Smaller decreases were also observed in the remaining tissues examined although the distribution patterns were similar. (auth)

51980 ZINC METABOLISM IN FARM ANIMALS. Miller, W. J. (Univ. of Georgia, Athens). pp 23-41 of Mineral Studies with Isotopes in Domestic Animals. Vienna; International Atomic Energy Agency (1971).

From Panel on mineral studies with isotopes in domestic animals; Vienna, Austria (28 Sep 1970). See STI/PUB-293; CONF-700966.

A review of the literature on zinc metabolism is presented. The following topics are discussed: mechanisms of zinc action; zinc deficiency; interrelation with other nutrients and factors; absorption of zinc; site and mechanism of zinc absorption; zinc excretion and endogenous losses; metabolism of ^{65}Zn in different organs and tissues; zinc excess; zinc content of tissues, milk, and eggs, and homeostatic control; zinc content and availability in feeds; and practical considerations. (H.L.W.)

51981 ZINC METABOLISM IN PIGS. Leibetseder, J. (Inst. of Physiology of the Veterinary College, Vienna). pp 51-63 of Mineral Studies with Isotopes in Domestic Animals. Vienna; International Atomic Energy Agency (1971).

From Panel on mineral studies with isotopes in domestic animals; Vienna, Austria (28 Sep 1970). See STI/PUB-293; CONF-700966.

Little is known about the dynamics of zinc metabolism in swine. Therefore zinc balance studies were performed in 18 boars with an average body weight of about 22 kilograms. In addition, total and organ compartment analyses were made with ^{65}Zn. The storage of zinc at the cellular level was investigated by cell fractionation and microautoradiographic procedures. During the relatively short period of the balance trials surprisingly high absorption rates of Zn were found. The analysis of the curve of the specific ^{65}Zn-plasma radioactivity showed one central and three peripheral compartments. Both the size of the compartments and the rate of transfer between the peripheral compartments and the central compartment were estimated. The results were verified by another type of calculation. Besides general compartment analysis of the whole body, 26 organs were analyzed in a similar way. The rates of transfer between blood plasma and the different organs and the Zn retention periods of these organs are given. (auth)

51982 SOME ASPECTS OF COPPER METABOLISM IN COWS. van den Hoek, J.; Binnerts, W. T. (Landbouwhogeschool, Wageningen, Netherlands). pp 65-6 of Mineral Studies with Isotopes in Domestic Animals. Vienna; International Atomic Energy Agency (1971).

From Panel on mineral studies with isotopes in domestic animals; Vienna, Austria (28 Sep 1970). See STI/PUB-293; CONF-700966.

Molybdenum sulphide, molybdenum oxide, and ammonium molybdate were administered orally to lactating cows and ^{64}Cu was injected intravenously daily for three to ten days. It was found that molybdenum compounds had a depressive effect on the uptake of ^{64}Cu by the liver. Both stable and injected radioactive copper were similarly and equally distributed throughout the liver. (H.L.W.)

51983 MANGANESE AND IRON METABOLISM STUDIES IN POULTRY AND SWINE. **Panic, B. (Institute for the Application of Nuclear Energy in Agriculture, Belgrade, Yugoslavia). pp 81-99 of Mineral Studies with Isotopes in Domestic Animals. Vienna; International Atomic Energy Agency (1971).**

From Panel on mineral studies with isotopes in domestic animals; Vienna, Austria (28 Sep 1970). See STI/PUB–293; CONF-700966.

The isotopes ^{54}Mn and ^{59}Fe have been used to study the influence of estrogens (oestradiol) on the metabolism and in particular the transport of manganese and iron in the blood of poultry with a view to contributing to a better understanding of the metabolism of these elements in laying hens and especially their transfer to ovocytes or egg yolks. It was found that oestrogen has a pronounced influence on ^{54}Mn and ^{59}Fe metabolism. The radioactivity of whole blood, plasma and all tissues and organs investigated was significantly higher in oestradiol-treated pullets than in controls. The plasma of the treated birds showed an especially marked increase in the level of radioactivity. The total iron in the plasma of laying hens and oestrogen-treated pullets was twice as high as the quantity of iron which could be bound by transferrin (TIBC). Thus, iron is not bound to transferrin only in the plasma of laying hens and oestrogen-treated pullets, but a considerable portion (about two thirds or more) is bound to a phosphoprotein, phosvitin. For this reason, special methods should be applied for plasma iron determination in these birds. The iron is more firmly bound to phosvitin than to transferrin, which indicates that the role of phosvitin in iron transport is specific: this protein enables iron to be transferred to the ovocytes, i.e. egg yolks. Investigations with ^{54}Mn suggested that manganese is also transferred to the ovocytes by the same phosphoprotein. All these results indicate that changes observed in manganese and iron metabolism in normal laying hens could be explained by the influence of oestrogens secreted by the ovary. Preliminary investigations on the in vitro binding of ^{59}Fe to proteins of gastric juice and gastro-intestinal mucosal extracts show that gastric juice and mucosal tissue extracts from the pyloric part of hog stomach contain a high-molecular protein component "gastroferrin" which is specifically able to bind iron. A similar component was found in mucosal extract of the proventriculus, duodenum, jejunum and ileum of laying hens. (auth)

51984 MEASUREMENT OF THE CONTAINED-MILK VOLUME OF THE MAMMARY GLAND USING RADIOACTIVE MARKERS. **Lengemann, F. W.; Snipes, M. B. (Cornell Univ., Ithaca, N. Y.). pp 111-19 of Mineral Studies with Isotopes in Domestic Animals. Vienna; International Atomic Energy Agency (1971).**

From Panel on mineral studies with isotopes in domestic animals; Vienna, Austria (28 Sep 1970). See STI/PUB–293; CONF-700966.

Cerium-141, ^{91}Y, ^{14}C-PEG-4000 and non-labelled PEG-4000 (polyethylene glycol, molecular weight 4000) were used in a dilution technique to determine the volume of milk in the mammary gland of the goat. A procedure evolved included introduction of label into the mammary gland via the teat meatus and an intravenous injection of 2 I.U. of oxytocin followed by hand manipulation of the udder to facilitate uniform mixing of cistern, duct and that portion of the alveolar milk let down in response to the oxytocin dose. Assay of any size of milk sample taken after this procedure allows an approximation of the mammary gland-contained milk volume at the time of the oxytocin dose. Results were consistent with ^{91}Y, ^{141}Ce and ^{14}C-PEG and stable PEG, indicating that all were estimating the same space. Recovery of ^{141}Ce and ^{14}C-PEG labels was essentially 100% three days after dosing the udder and no ^{141}Ce was detected in blood or urine within 24 h. Label was distributed uniformly among serial samples of the milk readily collectable after the mixing procedure; this represented 87.9% of the computed total milk volume. A portion of the residual milk recovered with a second dose of oxytocin showed ^{141}Ce and ^{14}C-PEG concentrations quite similar to those of the milk already collected. (auth)

51985 INFLUENCE OF EDTA ON THE RETENTION AND PATHWAYS OF EXCRETION OF COBALT, COPPER, IRON, MANGANESE, AND ZINC, AFTER PARENTERAL ADMINISTRATION TO SHEEP. **Vagg, M. J. (Institute for Research on Animal Diseases, Compton, Eng.). pp 135-8 of Mineral Studies with Isotopes in Domestic Animals. Vienna; International Atomic Energy Agency (1971).**

From Panel on mineral studies with isotopes in domestic animals; Vienna, Austria (28 Sep 1970). See STI/PUB–293; CONF-700966.

Pairs of sheep received intravenous injections of $^{58}CoCl_2$, $^{64}CuCl_2$, $^{59}CuCl_2$, $^{59}FeCl_3$, $^{54}MnCl_2$ or $^{65}ZnCl_2$, or the EDTA chelates of these metals. Urinary and faecal excretion of the trace metals was determined up to five days after their administration. The retention of the metal ions was not found to be related to the stability constants of their chelates with EDTA, which have the following order Fe^{3+}, Cu^{2+}, Zn^{2+}, Mn^{2+}, whereas their order of retention by sheep was Cu > Zn > Mn, Fe > Co. In particular, retention of copper was found to be very great, despite the high in vitro stability of the copper-EDTA complex. At five days after injection of ^{64}Cu-EDTA retention of the Cu was 93.9% of the dose administered. These results suggest that the in vivo stability of a given metal chelate is large, determined by the total body complexing power for the metal ion concerned, and cannot be predicted from the stability constant established in vitro. (auth)

51986 SOME ASPECTS OF MINERAL NUTRITION PROBLEMS IN EGYPT. **Abou Akkada, A. R. (Univ. of Alexandria, United Arab Republic). pp 177-81 of Mineral Studies with Isotopes in Domestic Animals. Vienna; International Atomic Energy Agency (1971).**

From Panel on mineral studies with isotopes in domestic animals; Vienna, Austria (28 Sep 1970). See STI/PUB–293; CONF-700966.

Under usual feeding practices in Egypt farm animals are likely to be supplied with a relative excess of calcium during the winter period, whereas phosphorus is relatively abundant in summer. These imbalances, which result in reproductive failures, impaired growth and decrease in productivity, were studied using ^{45}Ca and ^{32}P. Successful attempts were made to adjust the Ca/P ratios in feed to physiological levels by appropriate feed mixtures or mineral supplements. ^{32}P was used in these studies. Only a few trace minerals surveys have been carried out in Egypt. Iron, manganese and cobalt contents seem to be low in corn grains and therefore supplementation with these minerals is suggested for poultry rations in Egypt. Future research will cover surveys of the mineral studies of local feeds on farm animals, along with studies on trace mineral requirements of livestock under Egyptian conditions. Tracers and neutron activation techniques will be applied in these studies. (auth)

51987 MEASUREMENT OF THE RETENTION OF INTRAVENOUSLY INJECTED ^{47}Ca WITH A 4pi-LIQUID-SCINTILLATION-WHOLE-BODY-COUNTER IN HEALTHY PEOPLE AND PATIENTS WITH NEOPLASTIC OR OTHER DISEASES. **Roethlisberger, C.; Donath, A.; Poretti, G. G.; Zuppinger, A. (Univ., Bern). Radiol. Clin. Biol.; 40: No. 3, 200-11(1971). (In German).**

The retention of intravenously injected ^{47}Ca was measured with a 4π-liquid-scintillation-whole-body counter. The results were expressed by exponential functions. The retention of ^{47}Ca by persons with healthy bones depends on their age. Also patients with various diseases were examined; some of them showed abnormal ^{47}Ca-retention slopes. (auth)

51988 EFFECT OF TEMPERATURE ON ABSORPTION AND ACCUMULATION OF RADIO-STRONTIUM IN POTATO TUBERS. **Baranova, Z. A.; Mel'nikova, M. K. (Agrophysical Inst., Leningrad). Fiziol. Rast; 16: No. 9, 555-7(1969). (In Russian).**

One of the indicators of metabolic uptake by plants of nutrient ions is the existence of a temperature dependence of the process. In an effort to test ^{90}Sr in this way, potato tubers were placed in a solution of ^{90}Sr chloride, 0.3 μCi/ml, thermostatted at 1, 15, 25, and 35°C, respectively, for 24 hr. It was apparent from the results that an increase in temperature did not cause a significant increase in ^{90}Sr absorption by the tubers. The thermal coefficient of absorption of ^{90}Sr was practically constant, indicating that a diffusion process rather than a thermobiological process was manifest. (K.S.W.)

51989 COMPARISON OF THE AMOUNTS OF INORGANIC IODINE RECOVERED BY PAPER ELECTROPHORESIS OF DIGESTED, HOMOGENIZED, AND INTACT RAT THYROID LOBES. **Lybeck, H.; Leppaeluoto, J.; Virkkunen, P. (Univ. of Helsinki). Ann. Med. Exp. Biol. Fenn. (Helsinki); 49: 97-100 (1971).**

Rat thyroid lobes that were (a) intact, (b) homogenized or (c) homogenized and hydrolyzed were submitted to paper electrophoresis for 2 hr at $\frac{1}{2}$, 2, 4, and 24 hr after ip injection of $^{131}I^-$. The percentage of the total ^{131}I present as inorganic iodine in the intact lobes was significantly lower than that in the homogenized or hydrolyzed lobes. If human serum was added to the medium before homogenization, the values were lower, showing that serum proteins protected against deiodination. The $^{131}I^-$

contents measured by the "whole lobe technique" were 0.02 to 0.05%, these seem to be better expressions of the true physiologic iodide content of the thyroid than those measured after homogenization. (auth)

Radiation Effects

Refer also to abstracts 52175, 52176, 52182, 52189, 52210, 52253, and 52268.

51990 (A/CONF.49/P–633) RADIATION EFFECTS ON THE NUCLEIC ACIDS BASES. Teoule, R.; Cadet, J.; Polverelli, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires); Cier, A. (Lyon Univ. (France)). Apr 1971. 14p. (In French). (CONF-710901–258). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The knowledge of alterations in genetic materials produced by irradiation is of great interest in fundamental issues of modern biology (prebiotic conditions, mutations, species evolution, carcinogenic effects . . .). Since a few months, radiolesions induced in DNA by gamma rays in some microorganisms have been estimated by means of an indirect method requiring the chemical identification and the dosage of degradation products of one pyrimidine base. This demonstrates the importance of radiochemical studies which deal with DNA constituents. The more important studies in this field of DNA and RNA bases are reviewed. About thirty new products obtained in gamma radiolysis of purine and pyrimidine bases have been already isolated and for most of them structures were confirmed by synthesis. These studies allow us to define the fragmentation process under electronic impact and the stereochemistry of radioproducts. At low doses (100 rads, 10^{-3} M) the quantities of radioproducts are measured. A general degradation scheme shows differences and similarities in behaviour for the three pyrimidine bases (cytosine, thymine, uracil). Purines are found to be more radioresistant. Adenine was also attacked in position number eight but according to experimental conditions (10^{-5} rads, 2.5×10^{-5} M) involved for purines other products are formed and it is possible to detect derivatives of the saturation of the 5-6 double bond. In conclusion, prospectives in molecular radiobiology and practical consequences for environment problems and radioprotection are discussed. (auth)

51991 (JPRS–53801, pp 40–5) EFFECT OF ABDOMINAL OR HEAD REGION SHIELDING DURING GAMMA IRRADIATION OF DOGS ON THE CONTENT OF BLOOD SERUM PROTEIN FRACTIONS. Davydov, B. I.; Syzrantsev, Yu. K.; Razgovorov, B. L. Translated from Kosm. Biol. Med.; 5: No. 3, 27-30(1971).

Dogs were exposed to γ irradiation in a dose of 600 R with shielding of the abdominal (dose behind shield 150 and 300 R) or head (dose behind shield 150 R) regions. Protein fractions in the blood serum were determined by the paper electrophoresis method. A decrease in the albumin-globulin coefficient was noted regardless of shield localization; there was an increase in the content of β-globulins with normalization by the 100th day in the case of abdominal shielding and a residual dose behind the shield of 150 R and an increase in the albumin-globulin coefficient, for the most part due to the α_2 fraction. The increase in globulins correlates with an increase in glutamate-aspartate transferases. (auth)

51992 (UCLA–12–830) IN VITRO STUDIES OF BEATING HEART CELLS IN CULTURE. XVI. MYOSIN TURNOVER AND THE EFFECT OF SERUM. Desmond, Walter Jr.; Harary, Isaac (California Univ., Los Angeles). [1971]. Contract AT(04-1)-Gen-12. 40p. Dep. NTIS.

Myosin turnover in rat heart cells in culture was determined by measuring the rates of degradation and synthesis. The half life of myosin in complete growth medium was three and one half days. Irradiated cells in medium without serum do not divide and show an increased degradation and decreased rate of synthesis. Nondividing cells in complete growth medium turnover myosin at a normal rate. Serum contains factors which protect myosin against degradation and also stimulate synthesis. Myosin synthesis seems to be dependent on RNA synthesis, since in the presence of actinomycin D a decrease in myosin occurs between 2 to 4 hours. Cells in culture for one month maintain their ability to synthesize myosin. (auth)

51993 COVALENT BINDING OF AN ORGANIC NITROXIDE FREE RADICAL TO RADIATION-INDUCED LYSOZYME TRANSIENTS UNDER ANOXIC CONDITIONS. Brustad, Tor (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Int. J. Radiat. Phys. Chem.; 3: No. 1, 63-9(Jun 1971).

Steady-state irradiation and rapid mixing techniques were used to study the radiation induced complex formation between lysozyme and tritiated 2,2,6,6-tetramethyl-4-piperidone-N-oxyl (TAN) under anoxic conditions. Radiation-induced ^{3}H-TAN-lysozyme complexes were separated from TAN and low molecular TAN products on a Sephadex G-25 column and the extent of binding of TAN to lysozyme determined from the ^{3}H-activity profiles. No complex formation was observed when TAN was irradiated and at various times, t, afterwards (where $t > 10$ ms) mixed with unirradiated lysozyme. Considerable complex formation was observed when lysozyme was irradiated and at various times, t, afterwards (where $t < 200$ ms) mixed with unirradiated TAN. These data prove unequivocally that complexes are formed as a result of reactions between TAN and radiation-induced lysozyme transients. The apparent half-life of the latter is of the order of 50 ms. The yield of complex formation is doubled in N_2O-saturated solutions as compared to that in N_2, indicating that the lysozyme transients involved in the binding are OH-induced. The binding of TAN to radiation-induced lysozyme transients appears qualitatively to follow reactions rather similar to those for binding of TAN to radiation-induced DNA transients already described (Int. J. Radiat. Phys. Chem., 3: 55(1971)). (auth)

51994 BINDING OF AN ORGANIC NITROXIDE FREE RADICAL TO RADIATION-INDUCED DESOXYRIBONUCLEIC ACID (DNA) RADICALS UNDER ANOXIC CONDITIONS. Brustad, T.; Jones, W. B. G.; Nakken, K. F. (Norsk Hydro's Inst. for Cancer Research, Montebello, Norway). Int. J. Radiat. Phys. Chem.; 3: No. 1, 55-61(Jun 1971).

Rapid mixing techniques were used to study radiation-induced complex formation between desoxyribonucleic acid (DNA) and tritiated 2,2,6,6-tetramethyl-4-piperidone-N-oxyl (TAN) under anoxic conditions. Radiation-induced ^{3}H-TAN–DNA complexes were separated from TAN and low molecular weight TAN products on a Sephadex G-25 column and the extent of binding of TAN to DNA determined from the ^{3}H-activity profiles. No complex formation was observed when TAN was irradiated and at various times, Δt, afterwards ($\Delta t > 10$ ms) mixed with unirradiated DNA. Considerable complex formation was observed when DNA was irradiated and at various times afterwards mixed with unirradiated TAN. The data prove unequivocally that complex formation results from reactions between TAN and radiation-induced DNA transients. Assuming that the decay of the DNA transients is a first-order process, the data indicate that two DNA transients with different half-lives ($T' \approx 10$ s and $T'' \approx 70$ ms) are involved. (auth)

51995 EFFECTS OF IRON UPON THE RADIATION DAMAGE IN NON-HEME IRON PROTEINS. Cavatorta, P.; Crippa, P. R.; Vecli, A. (Univ., Parma, Italy). Biophysik; 7: 269-75 (1971).

Radical yield measurements on irradiated ferritin and transferrin in the dry state were carried out in order to test the role played by iron ions present in protein molecules on the radioresistance of these substances. In both cases, despite the high quantity of iron contained in ferritin and the direct linkage of two iron ions to the transferrin molecule, no difference between the radiation effects in native and iron-free proteins was observed. In the case of transferrin the lack of induction of secondary sulfur radicals by the presence of iron was observed. Some hypotheses about the interpretation of experimental results are discussed. (auth)

51996 REPAIR OF UV-DAMAGED DNA BY COMPETENT AND NON-COMPETENT CELLS OF BACILLUS SUBTILIS. Skavronskaya, A. G.; Kiryushkina, A. A. (Inst. of Epidemiology and Microbiology, Moscow). Genetika; 7: No. 7, 102-8(Jul 1971). (In Russian).

The influence of the competent state on the repair capacity of Bacillus subtilis was studied. It was found that competent cells have a normal repair. The transforming DNA exhibits an enhanced uv-sensitivity during the first minutes (1 to 3) after the penetration to competent cells. This phenomenon is not due to the loss of the repair activity of the recipient but probably is the result of the non-repairable (single stranded?) state of transforming DNA. After 30 min. contact with transforming DNA, the potential transformants attain the highest level of uv-resistance. However even at this moment the potential transformants are more uv-sensitive than the whole population of the competent recipient. There are several causes for the increased uv-sensitivity of potentional transformants: uv-inactivation of potential transformants; uv-inactivation of fragments of transforming DNA before their integration into the genome of the recipient cell; and the elimination of integrated fragments of transforming DNA in the course of the excision repair of recipient DNA. All these causes decrease the proportion of transformants in the irradiated culture. (auth)

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51997 MATHEMATICAL MODEL OF THE COURSE OF THE DNA SYNTHESIS IN MAMMALIAN CELLS AFTER ULTRAVIOLET IRRADIATION AND ITS USE IN THE DETERMINATION OF THE LENGTH OF THE REPLICON. Vanicek, J.; Klimek, M. (Inst. of Biophysics, Prague). Curr. Mod. Biol.; 3: 347-52(Feb 1971).

The chromosome of mammalian cells is divided into several shorter segments—replicons which replicate separately. When the cells are irradiated with ultraviolet radiation, pyrimidine dimers preventing the DNA-polymerase in its normal function and creating obstacles for completing the replication are formed. Using these facts as a basis we have derived a mathematical model of the course of the DNA synthesis in mammalian cells after ultraviolet irradiation. It has been proved that for the determination of the average length of units of replication in chromosomes of these cells the measurement of the intensity of post-radiation DNA synthesis in an asynchronous culture of mammalian cells can be used. Directions for the determination of this length using results of the measurement of the post-radiation synthesis are given. The method has been tested on mammalian L-cells. (auth)

51998 HEXOKINASE ACTIVITY IN ERYTHROCYTES, LIVER, AND BRAIN OF NORMAL RATS, ROENTGEN IRRADIATED RATS, AND RATS WITH GUERIN TUMOR AND CHRONIC HYPOXIA INDUCED WITH POTASSIUM CYANIDE. Cernatescu, C.; Trandafirescu, Maria; Haulica, Ana (Laboratorul de Biochimie, Iasi). Fiziol. Norm. Patol. (Bucharest); 17: No. 1, 85-90(1971). (In Rumanian).

Chronic administration of KCN produced a state of metabolic hypoxia in rats. In the treated animals an increase was noted in the glycolytic capacity of the red blood cells. A similar increase was observed in Guerin tumour bearing animals. The activity of hexokinase, an enzyme regulating cellular glycolysis, increases in the red blood cells and liver of both tumour-bearing animals and those with KCN-induced hypoxia. A parallelism exists between the hypothesis of O. Warburg on hypoxia as a primary cause of malignant transformation and the results obtained by the authors. (auth)

51999 EFFECT OF SOME FACTORS ON RADIATION SENSITIVITY OF AMOEBAS AND REPAIR OF RADIATION-INDUCED LESIONS. Skreb, Yvette. Arh. Hig. Rada Toksikol.; 19: 391-6(1968). (In Serbo-Croatian).

Following ultraviolet and gamma irradiation of amoebas, the surviving whole organisms, as well as fragments with and without nuclei, were studied with regard to changes in synthesis and amounts present of ribonucleic acid and protein. The results indicated that radiation resistance was minimum and the effects of administration of actinomycin D and of cooling were maximum in the presence of nucleic acid and undamaged cytoplasm. Actinomycin D administered before the irradiation increased the radiation sensitivity and hindered spontaneous repair, while cooling immediately after the irradiation accelerated the repair process. Cytoplasmic deoxyribonucleic acid did not enter into the repair process. (TTT)

52000 EFFECTS OF GAMMA RADIATIONS ON NUCLEIC ACIDS AND PROTEINS SYNTHESIS IN ACETABULARIA MEDITERRANEA. Bonotto, S.; Kirchmann, R. (CEN-SCK, Mol, Belg.). Bull. Soc. Roy. Bot. Belg.; 104: 125-35(1971). (In French).

Gamma radiation inhibits nucleic acid synthesis to a greater extent than it does protein synthesis. The synthesis of new ribosomes is also inhibited by γ radiation. Therefore, protein synthesis in the irradiated cell must take place primarily on preformed ribosomes. Preformed and radioresistant molecules of m-RNA must also be used during protein synthesis. (auth)

52001 DEOXYRIBONUCLEIC ACID TRANSFERRED FROM ULTRAVIOLET-IRRADIATED EXCISION-DEFECTIVE Hfr CELLS OF ESCHERICHIA COLI K-12. Wilkins, B. M.; Hollom, S. E.; Rupp, W. D. (Univ. of Leicester, Eng. Yale Univ., New Haven). J. Bacteriol.; 107: No. 2, 505-12(Aug 1971).

Deoxyribonucleic acid (DNA) transfer from ^{3}H-thymine-labeled Hfr cells was measured by determining the amount of radioactivity remaining after selective lysis of the donor cells in the mating mixture. DNA transfer was less effectively reduced by ultraviolet irradiation of excision-defective Hfr cells than was the yield of recombinants. The buoyant density of DNA transferred from unirradiated and irradiated Hfr cells was equivalent to that of double-stranded DNA. Mating-dependent DNA synthesis in the recipient was measured by mating Hfr cells deficient in thymidine kinase with irradiated thymine-requiring F^- cells in the presence of ^{3}H-thymine. The extent of such DNA synthesis approximated the amount of DNA transferred from unirradiated donors. Neither DNA transfer nor mating-dependent DNA synthesis could be reliably measured when both parents were irradiated. It is proposed that transferred Hfr DNA is replicated in the recipient and that this replication still occurs when the Hfr DNA contains dimers. (auth)

52002 STRUCTURAL CHANGES IN SOLID PROTEINS EXPOSED TO IONIZING RADIATION: GAMMA-IRRADIATED BOVINE SERUM ALBUMIN AS A MODEL SYSTEM. Rosen, C.-G. (Univ. of Stockholm). Int. J. Radiat. Biol.; 19: No. 6, 587-601 (1971).

Bovine serum albumin was γ-irradiated in the solid state, then subjected to analyses for the purpose of elucidating structural changes in the molecules. In addition to gel filtration, fluorescence polarization and the binding of a fluorescent probe were used in these studies. The results are largely compatible with recent results obtained with ribonuclease, but the new methods offer opportunities for studies of structural changes. There is a low but measurable probability for scission of the peptide chain, which is noticeable without unfolding of the molecule. Dimerization is a relatively efficient process, but in contrast to the results obtained with ribonuclease, no trimer was detected in the soluble fraction. It is shown that one hit in a protein molecule results in a very extensive destruction of hydrophobic structures and increased freedom of rotation of parts of the molecule. The acid expansion characteristic of serum albumin is to some extent restricted, indicating the formation of intramolecular bonds. The role of hydrophobic regions in proteins is discussed. It is suggested that the type of system and techniques used in this study may be used to further the understanding of radiation effects in biological membranes. (auth)

52003 INFLUENCE OF THE DIGESTIVE TRACT ON THE CATABOLISM OF SERUM ALBUMIN IN NORMAL AND IRRADIATED MICE. Telia, M.; Sassen, A.; Reuter, A. M.; Kennes, F.; Maisin, J. R. (CEN, Mol, Belgium). Biol. Gastro-Enterol.; 2: 192-8(1969). (In French).

The role of the gut in the catabolism of serum albumin is still controversial. In order to test this function, several experiments have been performed in normal, protected and non protected x-irradiated mice. Albumin concentration in various parts of the intestine has been determined by single immunodiffusion. In order to prevent proteolysis of the sample, a solution containing protease inhibitor has been used. With this method, undegraded albumin was found not only in the wall but also in the content of jejunum, thus showing some loss even in control animals. After 800 R x-rays, the amount of albumin increased slightly in the jejunum but was more pronounced in the large intestine. Mouse serum albumin labeled with ^{131}I was screened in vivo and then injected into various groups of mice. In normal animals, by the time equilibrium method, peak activity of the intestinal juice preceded slightly that of the wall. These two activities represent 2-3 p. 100 of the total body pool. Regression analysis of the linear part of the decay curves gives a half-life of 1.78 days for albumin in the gut. Fractional catabolic rates amount 1.25 mg in the jejunum and 0.4 mg in the colon. Their sum represents 5 p. 100 of the total daily degradation. After 800 R without chemical protection or 1,500 R x-irradiation with protection, a shorter half-life (1.40 days) was observed in the intestine. During the first five days after exposure, a large amount of free and protein-bound ^{131}I activity accumulated in the stomach content. However, 800 R of x-rays and protection suppressed the shortening of the half-life as well as the gastric accumulation. Rough estimation of the rate of albumin degradation in the whole gut after irradiation would be approximately 20 p. 100 of the total daily catabolism. (auth)

52004 BASE LIBERATION AND CONCOMITANT REACTIONS IN IRRADIATED DNA SOLUTIONS. Ullrich, M.; Hagen, U. (Kernforschungszentrum, Karlsruhe, Ger.). Int. J. Radiat. Biol.; 19: No. 6, 507-17(1971).

Irradiation of aqueous solutions of DNA causes liberation of free nucleobases and of compounds that behave chromatographically like nucleosides. These components can be separated from irradiated DNA by DEAE-Sephadex chromatography. Their amount increases linearly with dose, resulting in a G-value of 0.16 to 0.18. Further separation of the liberated products by ion-exchange chromatography on Dowex 50 × 4 and by thin-layer chromatography on cellulose plates shows that about 60% of the liberated material consists of nucleosides, part of which carries a damaged sugar molecule. Different methods used to determine the formation of malonic dialdehyde in irradiated DNA lead to the conclusion that this type of sugar damage does not contribute very much to the breakage of the DNA backbone. Several mechanisms leading to single strand breaks in DNA are discussed. (auth)

52005 MECHANISM OF RENAL ACID EXCRETION FOLLOWING X-IRRADIATION OF THE DOG. **Welbourne, Tomas C.; Spurr, G. B. (Univ. of Tennessee, Memphis). Radiat. Res.; 47: No. 2, 472-9(Aug 1971).**

Alterations in renal net acid excretion were studied in uninephrectomized dogs given 400 R total body irradiation. The early postirradiation (days 1–6) increase in acid excretion was the result of enhanced acid secretion rather than decreased base filtration and was related to a fall in Na$^+$ and K$^+$ excretion. The later postirradiation (days 7–11) decrease in net acid excretion was the result of diminished acid secretion. However, the decrease in acid secretion was not related to an increase in Na$^+$ or K$^+$ excretion, nor could it be attributed to an alteration in carbonic anhydrase activity. Rather the decrease in acid secretion appeared with an elevation in plasma Cl$^-$ and fall in plasma HCO$_3^-$ suggesting an increase in NaCl reabsorption at the expense of the Na$^+$ for H$^+$ exchange. (auth)

Immunology

Refer also to abstract 52178.

52006 (A/CONF.49/P–320) RESTORATION OF THE IMMUNE CAPACITY OF IRRADIATION ANIMALS BY LIVING CELLS. **Morgado, Fernando; Folch, Hugo; Esquivel, Patricio (Universidad Austral de Chile, Valdivia). Apr 1971. 18p. (In Spanish). (CONF-710901–485). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The restoration of the immunological efficiency of irradiated animals by grafting different cellular populations provides a critical method for understanding the physiological events that take place in the proliferation and differentiation of the cells involved in antibody synthesis. In the present study, mice given 900 R of whole-body irradiation were repopulated with bone marrow, thymus, spleen, or lymph node cells isogenic or xenogenic with the irradiated host, or a combination of these cellular populations. Simultaneously, the mice were immunized with sheep red blood cells (SRBC). In a second model, irradiated mice were grafted with a given cellular population and SRBC. Five days later the spleen of these mice were transferred to a second irradiated recipient plus a different cellular population and SRBC. Thereafter, the antibody production at the cellular and humoral level was measured. (auth)

52007 (A/CONF.49/P–355) SOME RESULTS OF THE APPLICATION OF IONIZING RADIATION IN HELMINTHOLOGY. Cuperlovic, K.; Movsesijan, M.; Jovanovic, M. (Inst. for the Application of Nuclear Energy in Agriculture, Veterinary Medicine, and Forestry, Zemun, Yugoslavia). May 1971. 16p. (CONF-710901–121). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In the field of immunoparasitology and pathophysiology of parasitic diseases the application of ionizing radiation and isotopes is necessary for contemporary investigations in this field of science. The first attempt was made in the investigations of the radiation effect on the Dictyocaulus filaria. The first stage larvae were more sensitive than the second stage larvae to the irradiation with 50 Kr x-ray. Males were more sensitive than females. Immunogenicity of irradiated third stage larvae was highly preserved. Guinea pigs as well as host sheep were protected by irradiated larvae against the infection with normal larvae. Field trials and practical vaccination in Yugoslavia gave very positive results in practical prevention of lung worm infection in sheep. The vaccination experiments in the farm animals are carried on in India and Iraq with the assistance of IAEA/FAO experts. Immature specimens of Echinococcus granulosus irradiated at 20 to 30 Kr x-rays inhibited the development of the terminal segment of the parasite, but the antigenic potentiality was preserved. Immunization of dogs with such irradiated specimens resulted in protection of animals against challenge. Similar changes were observed when metacercariae of Fasciola hepatica were irradiated at a level of 2 to 3 Kr. The antigenicity of such irradiated metacercariae is high but there is evidence of protection. The RBCs labelled with ^{51}Cr served for tracing the erythrocyte kinetics and measuring the blood loss in animals infected with F. hepatica and Haemonchus contortus. Immunoglobulins labelled with ^{131}I were used for estimation of the immunological reaction of animals to F. hepatica and to D. filaria. (auth)

52008 (RLO–2226-T-1-7) PROGRESS REPORT, 1951–1971. **(Oregon Univ., Portland. Div. of Medical Genetics). Contracts AT(45-1)–433; AT(45-1)–581; AT(45-1)–2226. 60p. Dep. NTIS.**

Studies on the molecular structure of the phytohemagglutinin of kidney beans (Phaseolus vulgaris) included isolation and characterization, biological activities, nature of the mitogenic factor, dissociation into subunits, and mechanism of action. Studies on lymphocyte transformation included: effect of D$_2$O on transformation of lymphocytes by phytohemagglutinin; effects of x radiation on transformation of lymphocytes by phytohemagglutinin; effects of immunogenic synthetic polyribonucleotides on lymphocytes; suppression of graft-versus-host reaction by phytohemagglutinin; and retardation of Rauscher Murine virus-induced leukemia by phytohemagglutinin. Studies were also conducted on human hemoglobin variants, erythrocyte aging and its effect on the oxygen dissociation curve, and human serum proteins. Progress is reported on human leukemic leukocyte studies, kinetics of cell proliferation, development of a nomogram for radioactivity counting statistics, development of an automatic ultrafiltration apparatus, tissue culture studies, and genetics, biochemistry, and hematology studies. Clinical studies on the use of ^{32}P for the treatment of leukemia, lymphomas, and polycythemia are discussed. (H.L.W.)

52009 ALLOGENIC TRANSPLANTS USING ^{60}Co IRRADIATED RABBIT TEETH WITH POLYVINYL SPONGE ROOT LINERS. **Hertz, Robert S. (Univ. of California, Los Angeles). J. S. Calif. State Dent. Ass.; 38: 1031-5(Dec 1970).**

Thirty incisor tooth transplants were performed on rabbits. Autologous and anogeneic grafts were subjected to irradiation and root liners of polyvinyl sponge were placed. Clinical radiographic and histological examination from periods of one to thirty weeks revealed that all transplants were subject to root resorption without regard to immunologic considerations or to irradiation directed at reducing the antigenicity of the grafts. Sterility of the teeth was demonstrated and a reversible color alteration of the enamel produced as a result of irradiation. The polyvinyl root liners proved to be difficult to manage and shortened the retention time of the transplants. Success of irradiated tooth allografts was not significantly greater than the non-irradiated transplants. (auth)

Ecology

Refer also to abstracts 51573, 51649, 51968, 52043–52045, 52050, 52054, 52063, 52064, 52230, and 53923.

52010 (A-AC–82/G/L.1298) BEHAVIOUR OF URANIUM IN THE BIOLOGICAL CHAIN. Pricter, B. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1969. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

A concise summary of uranium movement through the food chain of man is presented. Field experiments and testing of agricultural products such as grain and legumes for uranium build-up are briefly considered. Total and free uranium contents in the soil, and the behavior of uranium in the systems soil-plants, fodder-animal and plant husbandry, are examined. The booklet concludes with details of the distribution of uranium in milk products and other specific foods of man. (K.S.W.)

52011 (A/CONF.49/P–685) RADIONUCLIDE MIGRATION IN FORESTS AND RADIATION EFFECTS ON WOODY PLANTS. **Tikhomirov, F. A.; Alexakhin, R. M.; Fedorov, E. A.; Molchanov, A. A.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 16p. (CONF-710901–412). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The problems of primary distribution and subsequent migration of major fission fragments in forest plantations under a single and continuous radioactive aerosol fallout from the atmosphere are discussed. Quantity parameters are evaluated, which describe the interaction between the aerosols and the forest vegetation, and the vertical migration of radionuclides in the forest cenosis (the coefficient of initial retention of radionuclides by the crowns of trees, the period of radionuclide half losses by wood plant trees, the vertical migration rate of radionuclides in the forest soil profile, and the quantitative uptake of radionuclides by the wood plants and the forest soil. The quantitative relationship between the radionuclide concentration in different components of the wood plants and the radiation doses is established. It is shown that during the fallout of a radioactive fission-products mixture from the atmosphere beta-radiation is the major contribution to the absorbed dose accumulated by meristematic tissues of the wood plants. The radioecological after-effects following the forest irradiation are described. These after-effects are caused both by the direct irradiation and by the secondary changes associated with the violation of the biogeocenotic links between individual components of the forest cenosis as a result of the ionizing

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radiation (changes in the growth process and forest development changes in the species structure of the forest implantation and the soil cover, the microclimate change under the cover of the forest and so on). A possibility of recovery of the forest damaged by ionizing radiation under conditions of the long-lived radionuclides high concentration in the forest soil is studied. (auth)

52012 (PNE-914-F) RADIOIODINE STUDIES IN DAIRY COWS FOLLOWING PROJECT PALANQUIN. Black, Stuart C.; Engel, Ronald E.; Randecker, Victor W.; Barth, Delbert S. (Southwestern Radiological Health Lab., Las Vegas, Nev.). May 1971. 64p. Dep. NTIS.

A study was conducted during Project Palanquin in which seven dairy cows were exposed directly to the effluent cloud. Three of the cows were sacrificed for tissue distribution studies. The secretion of radioiodine in milk from the other four cows was measured for several weeks. Fifteen lactating cows were divided into three groups and were fed either fresh green chop or spread hay contaminated by the Palanquin effluent. The secretion of ^{131}I was measured in the milk of these latter cows for several weeks also. The peak milk concentration of ^{131}I was higher in the cows exposed directly to the effluent than it was in the cows eating contaminated forage. The possible reasons for this unexpected result are discussed and they indicate the problems encountered in conducting inhalation experiments in the field. The peak ^{131}I concentration appeared in 2 to 3 days in the milk of cows fed contaminated forage, and the peak milk concentration to peak forage concentration ratio was approximately 0.03. The peak ^{131}I concentration in forage or vegetation or the integrated air concentration was more accurate for predicting the peak milk concentration as compared to other surveillance data collected during this event. The tissue distribution study indicated that the peak thyroid concentration occurred at 76 hours after exposure, that 33.6% of the estimated intake was present in the cow 56 hours after exposure, and that the ^{131}I concentration in fetal thyroids was 2.4 times the maternal thyroid concentration. (auth)

52013 RADIOLOGICAL ASPECTS OF NUCLEAR POWER AND THE AQUATIC ENVIRONMENT. Seymour, Allyn H. (Univ. of Washington, Seattle). pp XI.1-16 of Nuclear Power and the Environment. Madison, Wis.; Univ. of Wisconsin (1970).

From Conference on nuclear power and the environment; Madison, Wis. (3 Apr 1970). See CONF-700415.

The radiological hazard to man related to the controlled disposal of low-level radioactive liquid wastes to the environment from normal operation of nuclear power reactors is negligible or controllable. A review of the critical pathways for radionuclides released from existing nuclear installations or power reactors shows that with one exception the dose to man from liquid releases is well below the ICRP allowable dose. The one exception, the ^{106}Ru-alga-laverbread-Welshman food chain, was remedied by control of the release of the radionuclide. Ecosystems have been directly damaged by nuclear device testing and by neutron irradiation from unshielded reactors and have been subjected to rather large radiation doses from gamma-ray sources and from radioactive wastes. In all cases, "—recovery tends to follow "ecologically normal" and predictable successional trends; i.e., patterns following damage from radiation are similar to those following fire, logging, or stripping of topsoil and other natural catastrophic events." More attention and effort has been focused upon radionuclides than upon any of the other contaminants that man has released to the environment, but this attention should not be interpreted as a measure of the relative hazards of the contaminants. (E.R.B.)

Genetics and Cytogenetics

Refer also to abstracts 51961, 51962, 51967, 51968, 52106, 52175, 52224, 52267, 52270, 52271, and 52279.

52014 (A/CONF.49/P-192) NUCLEAR METHODS FOR INCREASING FOOD PRODUCTION. Bozzini, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1971. 17p. (CONF-710901-191). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Among the programs of the Laboratory, mutagenesis of crop plants has been widely taken into consideration. The knowledge of best treatment methods, of selection procedures, of evaluation at radiobiological, genetical and agronomical levels of mutations induced in several agricultural crops has been one of the fundamental goals of the researches. Particularly, techniques of irradiation of several developmental stages of growth of plants have been developed and evaluated. Basic methodological researches and radiation breeding programs lead to the isolation of mutations of agronomical values. In this frame three mutant lines of durum wheat, recently registered and distributed to farmers, are worth mentioning. These varieties, Castelporziano, Castelfusano and Casteldelmonte, are characterized by better standing ability, higher fertilizer response and higher yield, thus contributing to the improvement of agriculture in Southern Italy and in the Mediterranean area, where durum wheat represents an important cash crop. Experiments on induced mutagenesis of two horticultural species of outstanding importance, tomato and pea, resulted in the isolation of lines of great promise for the mechanization of cultivation, harvesting and processing. In some fruit trees (cherry, peach and olive) somatic mutations potentially useful for an intensive mechanization of cultural practices have been identified. Their agricultural value will be evaluated in the following years. Increase of crop production has been pursued also at nutritional level. By the utilization of fertilizers labelled with ^{32}P and ^{15}N it was possible to establish, in two important cereal crops (rice and wheat), how and how much the efficiency of nitrogen of phosphorus fertilizer is a function of their formulation, of the time and technique of application and of the level of soil fertility. Precise indications as to agricultural practices have been therefore advanced. Theoretical and practical results, gathered in the last years, demonstrated, once again, the extreme usefulness of some applications in agriculture of techniques developed in the frame of nuclear researches. (auth)

52015 (A/CONF.49/P-329) USE OF ISOTOPES AND RADIATION FOR FOOD PRODUCTION INCREASE IN POLAND. Starzynski, K. (Agricultural Univ. of Warsaw, Poland). May 1971. 7p. (CONF-710901-275). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Since 1958, serious researches have been initiated to improve varieties of cultivated plants according to the climatic conditions of Poland. Ionizing radiations, mainly gamma rays, are employed to induce useful mutations. The researches concern mainly: determination of radiosensitivity of more important plant varieties; methods of radiation breeding of several plants; and definition of physiological and biochemical changes in induced mutants. The main results obtained so far are: the values of LD50 for several varieties have been determined; it has been established that differences in radiosensitivity of plants may be caused by changes of tertiary structure of DNA in embryos; several valuable mutants have been obtained for: wheat, barley, poppy, tabac, and ornamental plants; the works on radiation breeding of rye have been initiated—the plant which is the second important crop in the country. The use of isotopic methods in studies of soil fertility, ecology of insect pests, and animal nutrition is also considered. (E.R.B.)

52016 (A/CONF.49/P-354) IMPROVEMENT OF CEREAL GRAIN PROTEIN QUANTITY AND QUALITY THROUGH INDUCED MUTATION. Denic, M.; Dumanovic, J. (Dept. of Genetics and Plant Breeding, INEP, Belgrade). May 1971. 20p. (CONF-710901-120). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Some results of current study on mutations in wheat and maize aiming at increased protein production and/or improved protein quality are presented. The possibilities are discussed of inducing heritable variations in the content and composition of storage grain protein by the mutagenic treatments, gamma radiation, ethylenimine, and EMS. The results obtained indicate that it is possible by induced mutation to create variations in grain protein content as well as in protein composition. The changes in total amino acid composition, which are mainly discussed as resulting from the changes in the relative proportions of individual proteins or protein fractions, are discussed. The number of causes of induced variation in overall protein composition, using the principal component analysis are examined. It has been demonstrated that about 90 per cent of the total variation in the relative abundances of individual amino acids can be described in terms of 6 vectors in a sixteen-dimensional space. Although a direct translation of these vectors into definite proteins (protein fractions) is not yet possible, the picture obtained is in general agreement with a variation in relative amounts of individual proteins. (auth)

52017 (A/CONF.49/P-537) CROP IMPROVEMENT AND FERTILIZER STUDIES INCLUDING SOIL-PLANT RELATIONSHIPS USING RADIATIONS. Rao, N. S.; Mistry, K. B.; Gopal-Ayengar, A. R. (Bhabha Atomic Research Centre, Bombay (India)). May 1971. 24p. (CONF-710901-300). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Radiations are widely recognized as important tools for increasing the genetic variability in plants. Availability of irradiation facilities at this and other centres has generated considerable interest in the application of radiations for crop improvement and mutants with high yield and quality in a variety of crops have been isolated and released. In Arachis, TG-1, a large pod mutant evolved at Trombay, gave the highest recorded yield of 3317 Kg/ha under irrigation. A neutron induced mutant in castor developed by IARI which gave 3083 Kg/ha against 2005 Kg/ha of the cultivated variety was released. High yielding mutants were also obtained in Brassica, Campestris, and Brassica Juncea. Mutants in wheat with high protein content and amber colour were evolved from the Mexican dwarf varieties, Lerma Rojo and Sonora 64. In the areas of soil fertility and fertilizer use, isotopes have found extensive application in studies on the assessment of phosphorus fertility status of soils, evaluation of different phosphate fertilizers including nitrophosphates and polyphosphates for specific soil-crop conditions and optimum placement of phosphatic and nitrogenous fertilizers. Active root distribution pattern of rice, wheat, maize, sorghum, tobacco, oilseeds, and grapes as well as intervarietal differences in utilization of soil and fertilizer phosphate by these important crops were investigated. Radioisotopes were also employed in studies on soil-plant relations of sulphur, calcium, and zinc in soils where these nutrients are limiting factors for crop yields. Use of the well-established neutron diffraction method for determination of soil moisture has mainly centered around the calibration of equipment under contrasting soil regimes. Gamma-ray attenuation technique for bulk density measurement has found applications in studies of compaction of sandy and sandy loam soils. (auth)

52018 (A/CONF.49/P–690) MUTAGENIC EFFECT OF FAST NEUTRONS ON MICROORGANISMS. **Pasechnik, A. M.; Gornaja, M. S.; Luginina, T. N.; Matvejeva, M. D.; (and others) (Akademiya Nauk SSSR). Jun 1971. 11p. (CONF-710901–478). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A number of questions associated with the action of fast neutrons on the genetic changeability of aerobic and anaerobic bacteria that produce proteolytic ferments, antibiotics, and toxins were investigated. The fast neutrons irradiation was performed in a channel of the nuclear reactor BBP-M fitted for the biological research and having a γ radiation percentage that did not exceed 15%. Data were obtained which confirm the efficiency of using fast neutrons in the selection of strains with an increased antibody productivity displayed by the microorganisms belonging to the species Bacillus, Pseudomonas, Clostridium. The biological characteristics of radioinduced mutants of Bacillus mesentericus, Clostridium perfringes, and Pseudomonas sp., strain 31, are presented. (auth)

52019 (A/CONF.49/P–748) PROGRESS IN THE APPLICATION OF NUCLEAR METHODS IN INCREASING PRODUCTION OF RICE, SOYBEAN, AND COCONUT IN THE PHILIPPINES. Santos, Ibarra S. (Philippine Atomic Research Center, Manila). May 1971. 15p. (CONF-710901–327). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

For the last three or four years, mutation breeding work in rice and soybean and fertilizer placement study in coconut have been going on at the Philippine Atomic Energy Commission. Seventh-generation seeds of IR8-288-3 were exposed to ^{60}Co γ rays at the Philippine Atomic Research Center at dose levels varying from 10 to 70 kR. Breeders seed of the Lincoln soybean variety were exposed to thermal neutrons at the Brookhaven National Laboratory at flux levels varying from 2.02×10^{11} to 7.51×10^{13} n(th) per square centimeter per second. The ^{32}P placement study in 15- and 30-yr-old coconut trees involved distances of 1, 2, 3, and 4 meters from the bole and depths of 15, 30, 45, and 60 centimeters from the soil surface. Four mutant types induced from the IR8 rice variety appear most promising. Two of these mutant types possess improvement in grain shape and/or eating quality of both warm and cold cooked rice while retaining the most important assets of IR8 which are lodging resistance, responsiveness to nitrogen fertilization, and high yield potential. The other two types possess no improvement in grain shape or eating quality but were either improved in resistance to the rice blast disease or had longer culms and an increase in yield potential of about 10%. An acclimatized Lincoln mutant from the thermal-neutron-irradiated material, being two weeks earlier and photoperiod-insensitive and most probably producing more protein per unit area per day than the present recommended varieties, will be most useful to farmers who want to practice intensive land use. The greatest phosphorus absorption by coconut trees occurred when the fertilizer material was placed near the soil surface (15 to 30 centimeters depth) and at 1 to 2 meters distance from the bole. (auth)

52020 (A/CONF.49/P–844) INVESTIGATIONS ON THE USE OF IONIZING RADIATION IN PLANT BREEDING CARRIED OUT IN THE USSR. **Shkvarnikov, P. K.; Savin, V. N.; Khvostova, V. V.; Batygin, N. F.; (and others) (Ministry of Agriculture, USSR). Jun 1971. 17p. (CONF-710901–435). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A review of research on improvement of agricultural qualities of plants by means of radioinduced mutations is presented. A discussion is given of the relation of radioinduced chromosome damage to intracellular metabolism; the nature and fate of potential changes in chromosomes; and radioinduced inactivation of intracellular repair systems. Studies on effects of developmental stages on radiosensitivity of plants, comparison of effects of acute and chronic radiation, and modification of physiological and genetic effects of radiation are reviewed. Mutagenic effects of radiation and chemicals on soy beans, peas, maize, wheat, barley, potatoes, and cotton are discussed. (H.L.W.)

52021 (JPRS–53801, pp 77-83) CYTOGENETIC INVESTIGATIONS IN RELATION TO MANNED SPACE FLIGHT. **Grinio, L. P.; Krupina, T. N.; Bobkova, N. N. Translated from Kosm. Biol. Med.; 5: No. 3, 51-5(1971).**

No increase in chromosomal aberrations was found in the blood of test subjects during a 120-day bedrest experiment. No significant changes in the chromosomal apparatus were detected in cytogenetic examinations of a cosmonaut. These findings indicate that manned space flights made along the trajectories and in radiation environments involved up to this time are genetically safe. (auth)

52022 (NYO–4052-4) HUMAN RADIATION CYTOGENETICS AND PATHOLOGICAL AND BIOCHEMICAL STUDIES IN EXPERIMENTAL CARCINOGENESIS. **Final Progress Report, October 1, 1968–March 31, 1971. Lisco, Hermann (New England Deaconess Hospital, Boston, Mass. Cancer Research Inst.). Aug 1971. Contract AT(30-1)-4052. 20p. Dep. NTIS.**

Chromosome studies were carried out on blood leukocytes of various groups of people exposed to ionizing radiation. The groups included physicians, radiologists, physicists, and radiation workers in industry. Exposure was to external and in some cases to internal radiation as well. Elevated rates of chromosome aberrations were found in a significant proportion of all these groups. No correlation could be established between dose and aberration yield, although in general, higher aberration rates were seen in workers with histories of long exposure. It is concluded that chromosome aberration in peripheral leukocytes can be a useful biologic indicator of radiation exposure but that the method is not accurate enough to serve as a biological dosimeter of radiation exposure in man. (auth)

52023 GENETICAL CONTROL OF RADIOSENSITIVITY. **Report of Symposium held on July 28 to 29, 1969, Ohmiya, Japan. Gamma Field Symp.; No. 8, 1-129(1969). (In Japanese and English). (CONF-690731).**

Eight papers are included; separate abstracts were prepared for each. (E.E.H.)

For abstracts of individual papers see: 52024–52029, 52261, and 52262.

52024 HIGH SUSCEPTIBILITY OF AN X-RAY SENSITIVE E. COLI STRAIN TO SINGLE-STRAND BREAKS BY X-RAYS. **Kato, Takesi (Osaka Univ.). Gamma Field Symp.; No. 8, 1-15 (1969).**

From Symposium on genetical control of radiosensitivity; Ohmiya-machi, Ibaraki-ken, Japan (28 Jul 1969). See CONF-690731.

Experiments were conducted to determine the involvement of DNA polymerase in the repair of single-strand breaks and other unknown lesions induced by x rays in DNA. The x-radiosensitive mutant, Escherichia coli R 15, and its parent strain, E. coli B H/r30R, were examined for their ability to restore x-radioinduced single-strand breaks in DNA. The rate of appearance of slowly sedimenting fractions per unit dose was significantly higher in R15 than in H/r 30R. Defective DNA polymerase activity in R15 seemed to be due to amber type nonsense mutation res locus. The high radiosensitivity of R 15 was suppressed by the introduction of Su III^{+} gene. It was tentatively concluded that for R 15 single-strand breaks are not all lethal, but abortive repair synthesis occurs around the broken regions, which results in extensive single-strand degradation, making about one out of 30 abortive repairs a double-strand lethal break. Suppression of abnormal repair synthesis by Su III$^+$ gene reduced both inactivation of cells and production of single-strand breaks to the same extent. X radiation also directly induced double-strand breakage in DNA. If the data on double-strand breaks are applicable to R 15 and if double-strand breaks are lethal, only about one-third of the lethality caused by x radiation in R 15 is attributable to double-strand breaks. Decisive evidence for the role of double-strand breaks in lethality is still lacking. (E.E.H.)

52025 STUDIES OF RADIATION-SENSITIVE MUTANTS IN YEAST. Nakai, Sayaka (National Inst. of Radiological Sciences, Chiba, Japan). Gamma Field Symp.; No. 8, 17-31(1969).

From Symposium on genetical control of radiosensitivity; Ohmiya-machi, Ibaraki-ken, Japan (28 Jul 1969). See CONF-690731.

Data on the characteristics of radiosensitive Saccharomyces cerevisiae mutants in relation to radioinduced mutagenesis are summarized. Yields of different types of uv-induced mutations were markedly higher than those of the wild type at equal doses. This indicated that premutational damage of these types of mutations was dark-repairable. Similarly, damage leading to uv-radioinduced mitotic recombination was dark-repairable. X-ray sensitive and recombination deficient xs 1 mutant seemed to lack rec-type repair. Frequencies of induced mutation of an addition-deletion type in xs 1 strain were much higher than those in wild type strain at equal doses. However, other types of mutations were not significantly enhanced beyond the value of mutation frequency in wild type strain. Thus, the role of rec-type repair induced mutagenesis depends upon the molecular types of alleles examined. Mutagenesis of catalase decreasing mutant, xs 4, to x-radioinduced super-suppressor mutation increased over that in wild type strain. It may be suggested that an indirect effect of ionizing radiation may associate with radioinduced mutagenesis. (E.E.H.)

52026 GENETIC CONTROL OF RADIOSENSITIVITY IN DROSOPHILA MELANOGASTER. Ogaki, M.; Nakashima-Tanaka, E.; Matsunaga, S. (Univ. of Osaka Prefecture). Gamma Field Symp.; No. 8, 33-52(1969).

From Symposium on genetical control of radiosensitivity; Ohmiya-machi, Ibaraki-ken, Japan (28 Jul 1969). See CONF-690731.

Studies were made on the correlation of radiosensitivity between the adult and embryo stages of Drosophila melanogaster. Drosophila embryos were x irradiated at a dose rate of 500 R/min and adult flies were γ irradiated at a dose rate of 70 kR/hr. The radioresistance of the adult flies was about 500 times that of the 1 hr old embryos. The 3 hr old embryos were more resistant than those 1 hr or 5 hrs old, and the difference between radioresistant and radiosensitive strains was more distinct in the 3 hr old embryos. Strain differences in radiosensitivity was observed in both adult and early embryonic stages. However, these differences disappeared in later embryonic stages. The radiosensitivity in the early embryonic stage of Drosophila depends on the origin of the cytoplasm. Thus, maternal effects were observed in the early embryonic stage but no cytoplasmic effect was observed in either later embryonic stages or adult stages. Genetic analysis showed that the radioresistance of adult and early embryonic stages is due to a dominant gene or genes located on the third chromosome. (E.E.H.)

52027 ANALYSIS OF STRAIN DIFFERENCES IN RADIOSENSITIVITY OF THE SILKWORM. Tazima, Yataro; Murakami, Akio (National Inst. of Genetics, Misima, Japan). Gamma Field Symp.; No. 8, 53-68(1969).

From Symposium on genetical control of radiosensitivity; Ohmiya-machi, Ibaraki-ken, Japan (28 Jul 1969). See CONF-690731.

The relation between sensitivity to individual killing, cell killing, and mutation in strains of silkworms with differing radiosensitivities was investigated. Eggs were x irradiated with doses of 800, 1200, 1600, or 2000 R at a dose rate of 250 R/min. After hatching of the surviving embryos, hatchability was calculated and LD_{50} was estimated from dose response curves. The difference in LD_{50} between the most resistant and most sensitive strains was about three fold. Sensitivity to cell killing was studied with regard to spermatogenic cells using the fertility decline as a criterion. Sensitivity to mutation was compared at three different stages of spermatogenesis: spermatogonia, spermatids, and sperm. Marked differences in mutation response were observed among strains when spermatogonia were irradiated. The differences diminished as the germ cell stage advanced. Maternal effect was observed in F(1) of some cross combinations with regard to both embryonic killing and mutation. The experimental evidence that the variation in mutation frequencies among strains diminished markedly with the advancement of gametogenesis stage indicates that possibility of modification decreased with the advancement of the cell stage. (E.E.H.)

52028 SECOND TYPE OF GAMMA-RAY SENSITIVE GENE RS_2 IN SOYBEAN GLYCINE MAX (L.) MERRILL. Takagi, Yutaka (National Inst. of Radiation Breeding, Ohmiya, Japan). Gamma Field Symp.; No. 8, 83-94(1969).

From Symposium on genetical control of radiosensitivity; Ohmiya-machi, Ibaraki-ken, Japan (28 Jul 1969). See CONF-690731.

Several hundred soybean varieties were subjected to irradiation and their LD_{50} valves were estimated. The radiosensitivity of two representative varieties was controlled by a single major gene, rs_1 and the varieties with the gene in a dominant homozygous state were radioresistant. However, two varieties were found, which appear to be different from the other groups in their responses to γ radiation, Goishishirobana and Lexington. The F(1) and F(2) generations of crosses of these two varieties with Tachisuzunari and Shinmejiro were subjected to γ irradiation. From the results of irradiation of seeds and seedlings of F(2) of three of these crosses, it is postulated that there are at least two kinds of major genes associated with differential radiosensitivity among soybean varieties. This second type of gene, rs_2, acts in a recessive homozygous state in seed irradiation only. The existence of two types of major genes, rs_1 and rs_2, and their additive effect in seed irradiation may suggest that there are at least two or more different steps in recovery. (E.E.H.)

52029 VARIETAL DIFFERENCE IN SOMATIC MUTABILITY OF SUGI, CRYPTOMERIA JAPONICA D. DON. Ohba, Kihachiro (National Inst. of Radiation Breeding, Ohmiya, Japan); Murai, Masafumi. Gamma Field Symp.; No. 8, 109-20(1969).

From Symposium on genetical control of radiosensitivity; Ohmiya-machi, Ibaraki-ken, Japan (28 Jul 1969). See CONF-690731.

Varietal differences in the somatic mutability of 11 sugi cultivars, Cryptomeria japonica D. Don, and of 5 groups of F_1 plants derived from crosses among cultivars were investigated after acute γ radiation exposure at about 600 R. Somatic mutation rates per plant varied in the range of 231.4 and 36.1%. Somatic mutation rates per shoot, newly developed after irradiation, were distributed between 1.789% and 0.289%. Most of the mutations were chlorophyll changes. Morphological changes including abnormalities were also frequent. Waxless mutation was especially frequent in Kuma-sugi and Masuyama-sugi. Changes in winter coloration were found in 7 cultivars and deep red and green changes were noted in 3 cultivars. White leaf mutation was found only in Kuma-sugi and Aya-sugi. In F(1) plant irradiation, more than half of the F(1) plants which had Kuma-sugi as one of the parents produced somatic chlorophyll mutation at the rate of 0.3 to 0.5% per shoot. This indicates a major genic control of the somatic chlorophyll mutability in Kuma-sugi. (E.E.H.)

52030 GAMMA-RAY INDUCED VARIABILITY IN THE IODINE VALUE OF LINSEED OIL. Srinivasachar, D.; Malik, R. S. (IARI, New Delhi). Curr. Sci. (India); 40: No. 11, 298-9(5 Jun 1971).

Dry seeds of the linseed variety NPRR 9 were γ-irradiated and grown to the fourth selfed generation. Samples were taken in the fourth generation and analyzed for oil content and iodine value. Some of the samples contained higher oil contents and/or iodine values than did samples from the untreated parental strain. It was concluded that mutation breeding was especially useful in changing simply inherited characters in highly developed genic systems where standard hybridization methods may disturb the superior combination of genes. (E.R.B.)

52031 GENETIC BASIS FOR TWO TYPES OF RECESSIVE LETHALITY AT THE NOTCH LOCUS OF DROSOPHILA. Welshons, W. J. (Iowa State Univ., Ames). Genetics; 68: No. 2, 259-68(Jun 1971).

Two x-ray-induced Abruptex mutants are represented as mutant sites within the defined limits of the Notch gene. N/Ax heterozygotes are lethal, suggesting the cessation of a function common to both, but requiring explanation as to why the functional interruption is expressed phenotypically as Notch in one case and Abruptex in the other. — The unexpected results of a cis-trans comparison involving spl and Ax, plus a presumption relevant to cause, suggested that an Ax mutant site causes the synthesis of a highly aberrant, partly functional product, whereas, with a N site, the product is absent or nonfunctional. Various phenotypic comparisons are in accord with the hypothesis as are observations of coupled mutant combinations in the presence of

Enhancer-split.—This work is in harmony with the view that the original Dp(1;1)Ax^{28a} possesses two 3C7 bands. The Abruptex phenotype is due to a position effect that is caused by the adjacency of the two genetic elements, or one of the 3C7's is normal in function, whereas the other harbors a mutant site for Ax. (auth)

52032 ALBINO MUTANT IN PLANTAGO INSULARIS REQUIRING THIAMINE PYROPHOSPHATE. I. GENETICS. **Murr, Sandra M.; Stebbins, G. Ledyard (Univ. of California, Davis). Genetics; 68: No. 2, 231-43(Jun 1971).**

The albino mutant al in Plantago obtained from gamma radiation acts as a recessive gene giving a segregation ratio of 1 normal to 1 albino when the heterozygote is selfed. Departure from a 3: 1 ratio is attributed to complete trans linkage with a pollen-eliminator gene (pe). Half of the pollen from al^+pe/al pe^+ heterozygotes aborts, and the mechanism for elimination of al^+pe pollen grains is 100% effective. The albino and pollen-eliminator genes were mapped to chromosome 1 using translocation markers in somatic cells. Apparently when the seed producing the original X_1 plant was irradiated with gamma rays, three changes occurred: a reciprocal translocation between chromosomes 3 and 4; an albino-causing mutation on one homologue of chromosome 1; and a mutation causing the elimination of microspores on the other homologue of chromosome 1. (auth)

52033 CORRELATION BETWEEN THE RADIOSENSITIVITY AND THE MUTABILITY IN BARLEY. **Pitirimova, M. A.; Batygin, N. F. (Research Inst. of Agrophysics, Leningrad). Genetika; 7: No. 7, 159-61(Jul 1971). (In Russian).**

The problem of the relation between the state of experimental plants in M_1 and the mutability after gamma-irradiation of seeds is discussed. A direct positive correlation between the depressing effect of radiation in M_1 and the frequency of chlorophyll and sterile mutations in M_2 is shown. (auth)

52034 SOME TYPES OF MUTATIONS IN THE WINTER WHEAT INDUCED BY GAMMA IRRADIATION (^{137}Cs). **Korotkova, A. P. (Gorky Agricultural Experimental Station, USSR). Genetika; 7: No. 7, 23-8(Jul 1971). (In Russian).**

The frequent appearance of the main mutant groups and the segregation character of certain mutants was studied in different varieties and hybrids of winter wheat. As it was shown by a cytological study of the giant mutant, the gigantism was due to a chromosomal translocation. (auth)

52035 INVESTIGATION OF CHROMATID REARRANGEMENTS INDUCED BY THE IRRADIATION OF VICIA FABA SPROUTS AS RELATED TO THE VERIFICATION OF RIVELL'S EXCHANGE HYPOTHESIS. **Ganassi, E. E.; Suikova, L. A.; Aptikaeva, G. F.; Bregadze, I. F.; Eidus, L. Kh. (Inst. of Biological Physics, Pushchino-on-Oka, USSR). Genetika; 7: No. 7, 64-70(Jul 1971). (In Russian).**

An analysis of the main principles and consequences of the Rivell's exchange hypothesis on the mechanism of chromosome aberrations formation was carried out. The data obtained on the irradiated Vicia faba lateral seedling roots as well as data presented in the literature were discussed. A discrepancy between the experimental results and the theoretical considerations of the exchange hypothesis was observed. It is assumed that the mechanism suggested by Rivell is responsible only for a certain proportion of chromatid deletions. (auth)

52036 INDUCTION OF MUTATIONS IN ALTERNATIVE BARLEY IN CONNECTION WITH THE TYPE OF DEVELOPMENT. **Pyl'nev, V. M.; Orlyuk, A. P. (All-Union Genetic Selection Inst., Odessa). Tsitol. Genet.; 4: No. 1, 36-42(1970). (In Russian).**

The frequency and spectrum of chlorophyll mutations induced with γ-rays in the Odessky 17 alternative variety of barley were studied under conditions of winter and spring growth habit (the spring and winter sowing). The M_1 plants with the spring growth habit showed a tendency to increase the chlorophyll mutations in M_2. The largest number of mutations and a wider spectrum of morphological and physiological mutations were discovered for M_1 and M_2 plants with the winter growth habit. The change in mode of life for M_1 and M_2 plants resulted in a considerable change in the frequency and spectrum of mutations on account of transition of potential changes into true ones. (auth)

52037 ULTRAVIOLET SENSITIVITY OF HAEMOPHILUS INFLUENZAE TRANSFORMING DNA. I. EFFECTS OF GENETIC MISMATCH AND TARGET SIZE. **Day III, Rufus S.; Rupert, Claud S. (Univ. of Texas, Dallas). Mutat. Res.; 11: No. 3, 293-311(Mar 1971).**

The transforming ability of the multi-site Haemophilus influenzae marker Nb_2 (resistance to 50 μg/ml novobiocin) is known to be about 2 times less than that of one of its component markers Nb_1 (resistance to 5 μg/ml novobiocin), while its uv sensitivity is about 10 times greater when transforming wild-type cells. We have resolved Nb_2 into Nb_1 plus a new marker Nb_3, which by itself confers resistance to 1 μg/ml novobiocin, and have compared uv-survival curves for all assayable transformations of wild-type, Nb_1, and Nb_3-marked cells by Nb_1, Nb_2, and Nb_3 DNAs. Results show that reducing the "target size" of the donor DNA by requiring a recombination to occur between the Nb_1 and Nb_3 loci decreases the sensitivity of either marker (dose modification factor ~0.3), and a difference between the integrated portion of the transforming DNA and the recipient cell genome at the Nb_2 locus ("mismatch") increases the uv sensitivity (dose modification factor ~10) of either marker. Such an effect, which is responsible for the high uv sensitivity of Nb_2-marked DNA assayed on wild-type cells, does not arise when a mismatch occurs at the Nb_1 locus. These 2 effects, acting independently, account for the 4 discrete classes of uv sensitivity observed in these experiments. Ultraviolet-inactivation curves with an Nb_3 mismatch condition show about the same sensitivity in HCR^+ and HCR^- recipients, while, with a match condition, sensitivity is higher in HCR^- cells, suggesting that mismatch prevents repair even in HCR^+ cells. (auth)

52038 ANOTHER TWO GENES CONTROLLING MITOTIC INTRAGENIC RECOMBINATION AND RECOVERY FROM UV DAMAGE IN ASPERGILLUS NIDULANS. II. RECOMBINATION BEHAVIOUR AND X-RAY-SENSITIVITY OF uvsD AND uvsE MUTANTS. **Fortuin, J. J. H. (State Univ., Utrecht). Mutat. Res.; 11: No. 3, 265-77(Mar 1971).**

Strains of Aspergillus nidulans carrying a uvsD or uvsE mutation, and previously shown to be uv sensitive, show altered recombination frequencies. The uvsD mutation enhances, the uvsE mutation diminishes, spontaneous mitotic intragenic recombination. Crosses of the type uvsD × D and uvs E × E are largely sterile. Among the progeny of a uvsD × uvsD cross many diploids are found. The uvsD and E mutations are recessive. Germinating uvsE conidia are x-ray sensitive. Reverse mutants of uvsD and uvsE are less uv sensitive and have a less abnormal frequency of recombination than the parental mutants. (auth)

52039 INDUCTION OF MITOTIC GENE CONVERSION BY MUTAGENS. **Zimmermann, F. K. (Forstbotanisches Institut, Freiburg i. B.). Mutat. Res.; 11: No. 3, 327-37(Mar 1971).**

Mitotic gene conversion generates wild-type alleles from a pair of differently inactive alleles combined in a heteroallelic diploid. If the inactivity of those alleles causes a nutritional requirement, production of wild-type recombinants by mitotic gene conversion can be followed, in the yeast Saccharomyces cerevisiae, by simply plating cells on selective media. Mitotic gene conversion can be induced by a large variety of mutagens: ionizing radiation, uv irradiation, methylating, ethylating, propylating and butylating agents, as well as by other alkylating agents such as ethyleneimines, nitrogen mustards, lactones, epoxides, sultones, metabolic derivatives of carcinogenic, aromatic amines, deaminating nitrous acid, radical-producing hydroxyurea and the acridine mustard 2-methoxy-6-chloro-9-(2-chloroethylaminopropylamino)acridine · 2HCl, ICR 191. The ability of an agent to induce mitotic gene conversion has mostly been demonstrated by using just 1 diploid strain of Saccharomyces cerevisiae heteroallelic for 2 loci. No example of mutagen specificity has been found so far. This is in contrast to many mutational systems. Mitotic gene conversion is considered to be an indicator of repair of induced DNA damage. The very easy and reproducible handling of mitotic gene conversion makes it a useful tool for routine testing of large numbers of chemicals for a potential genetic activity. This can be done either by treating cell suspensions or by a spot test procedure in which cells of the indicator strain for mitotic gene conversion are plated on a medium selective for convertants. The agent to be tested is added to the center of the medium plate, and within 5-6 days strong genetically active agents can be recognized by a ring of convertants around the spot of application. (auth)

52040 INHERITANCE OF X-RAY INDUCED LEAF AND STEM MUTATIONS IN JUTE (CORCHORUS-OLITORIUS LINN.). **Ghosh, N.; Sen, S. (Univ. of Kalyani, Nadia, India). Z. Pflanzenzuecht.; 65: No. 3, 265-72(May 1971).**

"Palmate", "crinckle", "glossy" leaf and "dwarf" plants with "thick" leaf are x-ray induced, true breeding mutations, isolated from jute (Corchorus olitorius Linn.). Genetical studies revealed a recessive monogenic control of each of these mutant traits. These mutant genes have been designated as pm, cr, gl, dw and thl respectively. It has also been found that pm pm and cr cr genes assort independently and the gene for tallness (Dw) is epistatic to the recessive gene for thick leaf (thl). Modified trihybrid ratios have also been obtained owing to the dominant epistasis of tallness (Dw) over thick lead (thl) and recessive epistasis of crinckle (cr) on thick leaf (thl). (auth)

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52041 COMPARATIVE STUDIES OF THE BIOLOGICAL EFFECTIVENESS OF NITROGEN MUSTARDS, ETHYLENIMINE, AND γ RAYS. Nawar, M. M.; Konzak, C. F.; Nilan, R. A. (Washington State Univ., Pullman). Mutat. Res.; 11: No. 3, 339-46(Mar 1971).

An exploratory study of the differential effectiveness and efficiency with which a group of structurally related aliphatic nitrogen mustards, ethyleneimine, and γ-rays induce biological, especially genetic changes in barley was made. Results showed that the polyfunctional nitrogen mustards were markedly more effective in depressing growth and breaking chromosomes than were the monofunctional nitrogen mustard or ethyleneimine. The monofunctional chemicals induced high levels of chlorophyll-deficient mutations whereas polyfunctional nitrogen mustards elicited only a few such mutations. The low level of chlorophyll-deficient mutations resulting from treatments with polyfunctional nitrogen mustards was probably due to the elimination of cells carrying potential genetic changes for such mutations during the early stages of ontogeny, rather than to the inability of these chemicals to induce the initial lesions for chlorophyll-deficient mutations. γ-ray treatments induced high frequencies of both chromosomal aberrations and chlorophyll-deficient mutations with comparatively less growth depression. The ratio of dicentric bridges to acentric fragments, observed at the first anaphase following treatment, was much higher for γ-rays than for any of the chemicals. (auth)

52042 COMBINED TREATMENT OF PLANTS WITH IRRADIATION AND ETHYLENIMINE. Olimpienko, G. S.; Mitrofanov, Yu. A.; Vorob'eva, E. A. Tsitol. Genet.; 4: No. 6, 527-31(1970). (In Russian).

The use of combined treatment with 7 kR x radiation and ethylenimine for obtaining economically beneficial mutants in barley and wheat was investigated. A protective effect of ethylenimine was found in the first generation manifested by an increase in survival rate and fertility of irradiated plants. In the second generation, a decrease in the number of chlorophyll mutants and sterility was observed. There was a slight increase in the yield of viable mutants. (auth)

Health Physics and Safety

Refer also to abstracts 51785–51795, and 53458.

Radioactive Contamination and Decontamination

Refer also to abstracts 51397, 51573, 51970, 51975, and 52011–52013.

52043 (A/CONF.49/P–684) PROSPECTS OF WIDE PEACEFUL USE OF ATOMIC ENERGY WITH RADIATION SAFETY OF POPULATION. Izrael, Yu. A.; Teverovsky, E. N. Jun 1971. 13p. (CONF-710901–321). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Increasing peaceful uses of atomic energy may result in a possible release of radioactive products into the environment; this is to be strictly controlled in accordance with the ICRP regulations and the national standards of radiation safety for populations. A calculation of the air amount necessary for the dilution of various isotopes and impurities released by chemical or nuclear fuel power plants is presented. It is shown that every energy unit produced by fission requires less air for diluting the released products to the permissible concentration than that produced by conventional fuel, considering that less than 0.1% of long-living radioactive products may be released into the atmosphere. This concentration has now been achieved. This is why nuclear fuel is preferable from the point of safety than chemical fuel. (auth)

52044 (A/CONF.49/P–686) BIOLOGICAL EFFECTS AND BEHAVIOR OF RADIOACTIVE FISSION PRODUCTS IN THE AGRICULTURE CHAINS. Fedorov, E. A.; Prister, B. S.; Romanov, G. N.; Burov, N. I.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 21p. (CONF-710901–413). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Agricultural aspects of the radiation situation which can occur in the case of the environmental contamination with a mixture of fission products of various ages and following neutron soil activation are considered. Experimental data are presented which were obtained in investigations conducted under natural conditions and on experimental areas. A connection is established between the density of radioactive contamination of agricultural lands with a fresh mixture of fission products, the degree of radionuclide accumulation in the farm crops following their contamination during different phases of their growth, and the doses of γ and contact β-radiation received by plants and subsequent radiation injury of farm crop seedlings. (auth)

52045 (NVO–269-11) AMCHITKA RADIOBIOLOGICAL PROGRAM. Progress Report, July 1970–April 1971. Held, Edward E. (Washington Univ., Seattle. Coll. of Fisheries). Jul 1971. Contract AT(26-1)-269. 38p. Dep. NTIS.

Data are presented on the content of radionuclides in biological and environmental samples from Amchitka Island. Samples collected in September 1970, and fish collected in September 1969, contained radionuclides that were naturally occurring, from worldwide atmospheric fallout, or were carried to the area by oceanic currents, with the exception of tritium which was previously reported to be present in ponds and test wells near the surface ground zero of the Long Shot nuclear detonation. The concentrations of the radionuclides found were small and within the range of values reported for similar samples from other parts of the northern hemisphere. Iron-55 was the predominant fallout radionuclide in fish. Other fallout radionuclides identified in various samples were ^{46}Sc, ^{54}Mn, ^{60}Co, ^{65}Zn, ^{95}Zr–^{95}Nb, ^{103}Ru, ^{106}Ru–^{106}Rh, ^{108m}Ag, ^{110m}Ag, ^{125}Sb, and ^{137}Cs. (auth)

52046 (UUIP–739) CONTENT OF ^{137}Cs IN SOME UPPSALA PLACENTA SAMPLES. Stenberg, Allan (Uppsala Univ. (Sweden). Inst. of Physics). Apr 1971. 14p. Dep. NTIS (U. S. Sales Only).

The quantities of ^{137}Cs and potassium have been determined in some placenta samples and in a few tobacco samples. Tobacco-smoking is proposed as one possible mode of ^{137}Cs intake. (auth)

52047 CONTAMINATION CONTROL: A VERY OLD, NEW FIELD. Garst, D. M.; Trauth, C. A. Jr. (Sandia Labs., Albuquerque, N. Mex.). pp 651.1-8 of Proceedings of the 24th Annual ISA Conference. Pittsburgh; Instrument Society of America (1969).

From twenty-fourth annual conference of Instrument Society of America: Houston, Tex. (27 Oct 1969). See CONF-691004–(Pt.4).

A practical overview of contamination control is presented, including its universal character, the structure of the field, the general nature of contamination control problems, and a brief discussion of the currently available means for controlling contamination. (W.H.K.)

52048 CLEAN ROOM: A VITAL ELEMENT IN CONTAMINATION CONTROL. Reynolds, Marcel C. (Sandia Labs., Albuquerque, N. Mex.). pp 652.1-7 of Proceedings of the 24th Annual ISA Conference. Pittsburgh; Instrument Society of America (1969).

From twenty-fourth annual conference of Instrument Society of America; Houston, Tex. (27 Oct 1969). See CONF-691004–(Pt.4).

The position of the clean room in the total contamination control picture is described. A model of contamination control is used to illustrate this, and to relate other contamination control factors to the clean room. A general guide is presented for selection of clean room types to attain specific levels of airborne contamination control. The arrangements, types, and sizes of operations have different effects in different types of clean rooms. Generally, the vertical flow room is least affected by variations in clean room arrangements. However, other types of clean rooms may be needed to meet special requirements and should always be considered for function, cost, and operation. (auth)

52049 INSTRUMENTATION AND METHODOLOGY IN MEASUREMENT OF VIABLE AND NONVIABLE CONTAMINATION. Whitfield, W. J.; Garst, D. M.; Lindell, K. F. (Sandia Labs., Albuquerque, N. Mex.). pp 653.1-5 of Proceedings of the 24th Annual ISA Conference. Pittsburgh; Instrument Society of America (1969).

From twenty-fourth annual conference of Instrument Society of America; Houston, Tex. (27 Oct 1969). See CONF-691004–(Pt.4).

Measurement of contamination is in most cases highly specialized and any one method usually measures a narrow range of contaminants. Many times several instruments are required to measure a single contaminant type over a range of concentrations or particle sizes. Basic principles, instrumentation, ranges, and sensitivities of measurement methods for viable and nonviable particle contamination are described. Several recently developed methods and equipment are described as well as some critical needs for development of new methods and instrumentation. (auth)

52050 NUCLEAR POWER PLANT EMISSIONS. Janssen, U. Mitt. Ver. Grosskesselbetr.; 51: No. 2, 143-7(1971). (In German).

The basis for, and development of statutory limitations for the release of radioactive emissions from nuclear power plants are discussed. The actual emission values found under normal conditions and during emergencies are given. Tritium emission is used to illustrate the need for tracing emitted radioactive substances so that possible biological accumulation can be recognized and prevented. (INIS)

52051 SECONDARY CONTAMINATION OF THE SURFACE OF A MATERIAL BY ABSORBED RADIOACTIVE SUBSTANCES. Kononovich, A. L.; Perfilova, E. M. This paper was summarized in At. Energ. (USSR); 29: No. 4, 287-8(Oct 1970) as paper No. 436/5738. (In Russian).

The degree to which surface contamination can become built up again to its initial level, by absorbed activity, after decontamination has been carried out was calculated on the basis of a theoretical treatment of the process of exchange of radioactive material between adsorbed phase and absorbed phase, in the vicinity of the surface material. The calculations were based on an approximate simplified model in which the two phases were treated as independent phases. The assumption was that the concentration of contaminants was low, that the material would be capable of undergoing chemical changes only in the transition from one phase to the other, that the rate of exchange is proportional to the difference between the true concentration and the equilibrium concentration of the material, and that diffusion of the contaminant atoms through the bulk of the material is described by Ficke's law. (auth)

52052 DECONTAMINATION OF SKIN CONTAMINATED WITH RADIONUCLIDES. Jaworowski, Zbigniew (Centralne Laboratorium Ochrony Radiologicznej, Warsaw); Kawczak, Jerzy; Turowicz, Nadzieja; Zylicz, Elzbieta. Nukleonika; 16: No. 3-4, 175-80(1971). (In Polish).

The effectiveness of 17 decontaminating agents was tested for the decontamination of skin contaminated with 14 radioactive substances commonly used in isotopic laboratories. Data are included on the best decontaminating agent for each of the radioactive substances. (auth)

52053 INCORPORATION HAZARDS AND THEIR ESTIMATION. Moehrle, G.; Schieferdecker, H. (Kernforschungszentrum, Karlsruhe, Ger.). Radiologe; 10: No. 9, 381-5(Sep 1970). (In German).

The incorporation of radioactive material is discussed with respect to hazard. The survey considers the effective half-life of incorporated radionuclides and ways of incorporation and distribution in the body. Delineated is determination of the incorporated radioactivity by whole-body counting and by excretion analysis. It was concluded that intervals between examination of personnel should not exceed the effective half-life of the radionuclide under consideration. Measurements of incorporation should be performed weekly for tritium and ^{60}Co, monthly for uranium, and four times a year for plutonium. (H.B.G.)

52054 SUMMARY OF SIX YEARS OF RESEARCH IN RADIOCONTAMINATION OF FOOD. Cantillon, C. E. (Inst. of Hygiene and Epidemiology, Brussels). J. Belge Radiol.; 54: No. 3, 433-9(May-Jun 1971). (In French).

The Institut d'Hygiène et d'Epidémiologie and the Centre d'Etude de l'Energie Nucléaire have jointly set up a program of analyses for measuring the level of contamination in the principal kinds of foods and estimating the daily ingestion of radioactivity due to food. The sampling program and the trend in the radiocontamination from 1964 to 1969 are described. The following observations may be made. There is a close relationship between variations in milk contamination and those of the total diet and a decrease in daily ingestion, rather slow for ^{90}Sr, much faster for ^{137}Cs. For ^{90}Sr, the curve has now levelled out, and the inaccuracy of sampling therefore takes on a great importance. The radioactivity ingested has never been a danger and has remained below the level generally accepted for the population. (auth)

52055 DATA. SECTION IV. OTHER DATA. Radiol. Health Data Rep.; 12: No. 6, 337-61(Jun 1971).

Data are presented on the ^{90}Sr content of human bone samples collected at various locations in the USA during July to September 1970. The calcium content and the ^{90}Sr to calcium ratio in these samples are also given. Data on age, sex, and bone type for each sample is included. Summaries are presented of the environmental radioactivity levels at Atomics International (Canoga Park, California) during July to December 1970 and at Hanford Atomic Products Operation (Richland, Washington) during January to December 1968. (E.R.B.)

52056 DATA. SECTION III. AIR AND DEPOSITION. Radiol. Health Data Rep.; 12: No. 6, 331-6(Jun 1971).

The gross β radioactivity in surface air and precipitation samples collected at various locations throughout North, Central, and South America during February 1971 is presented. The ^{238}Pu and ^{239}Pu contents of airborne particulates at various locations in the USA during July to December 1970 are also given. All data are presented in tabular form. (E.R.B.)

52057 DATA. SECTION II. WATER. Radiol. Health Data Rep.; 12: No. 6, 330(Jun 1971).

Programs for the radiation monitoring of public water supplies, ground waters, and surface waters in the USA are reviewed briefly. References are presented to results obtained from the sampling programs during the period 1968 through 1970. (E.R.B.)

52058 DATA. SECTION I. MILK AND FOOD. Radiol. Health Data Rep.; 12: No. 6, 319-29(Jun 1971).

Data are presented on the content of ^{90}Sr, ^{131}I, and ^{137}Cs in samples of milk collected at various locations in North, Central, and South America during February 1971. Data for the preceding 12-month period are included for purposes of comparison. The average ^{90}Sr-to-calcium ratios in samples of liquid and powdered whole milk from various locations in New York are presented for each month during 1969. (E.R.B.)

52059 APPLICATION OF ANALYSIS OF CO-VARIANCE IN STUDIES OF RADIOACTIVE CONTAMINATION. Orlando, G.; Balestra, V. (Univ., Genoa). G. Ig. Med. Prev.; 9: No. 4, 349-58(Oct-Dec 1968). (In Italian).

The content of ^{90}Sr in cow's milk from nine Italian towns during November 1961 to December 1964 was evaluated for a possible connection with the variability of ^{137}Cs, Ca, and K. Following an analysis of covariance, it was established that the monthly and local differences in the amount of ^{90}Sr retained their import even after any possible interaction from the variability of the other elements was eliminated. (E.R.B.)

52060 RADIOACTIVE WASTE DISCHARGES TO THE ENVIRONMENT FROM A NUCLEAR FUEL REPROCESSING PLANT. Logsdon, Joe E.; Hickey, John W. N. Radiol. Health Data Rep.; 12: No. 6, 305-12(Jun 1971).

The Nuclear Fuel Services fuel reprocessing plant has been in operation since 1966 and has provided valuable experience in waste management problems related to this type of facility. The large quantities of radioactivity that must be controlled at a nuclear fuel reprocessing plant virtually eliminate discharge-and-dilution as a satisfactory method of disposing of radionuclides that concentrate through environmental media. Radionuclides such as strontium-90, ruthenium-106, cesium-137, cesium-134, cobalt-60, tritium, and krypton-85 have been found in environmental media around NFS. These indicate that pathways to the public do exist as a result of operation of the facility. However, studies to date have indicated that typical population doses in the vicinity of NFS are not significantly different from doses received in other portions of the State. (auth)

Dosimetry and Monitoring

Refer also to abstracts 51859, 51907, 51917, 52120, 52152, 52156, 52174, 52196, 52242, 52889, 53441, 53447, 53501, 53784, and 54008.

52061 (A/CONF.49/P-395) PERSONAL DOSE BURDEN CAUSED BY NUCLEAR RESEARCH CENTERS. INVESTIGATIONS AND EXPERIENCES OF THE NUCLEAR RESEARCH CENTERS OF KARLSRUHE AND JUELICH. Kiefer, H.; Koenig, L. A.; Piesch, E.; Rose, E.; Vogt, K. J. (Kernforschungszentrum, Karlsruhe (West Germany). Kernforschungsanlage, Juelich (West Germany)). Apr 1971. 27p. (CONF-710901-139). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

At the Juelich DIDO reactor site and Karlsruhe Nuclear Research Centers investigations on the radiation dose to the personnel working in restricted and controlled areas and to the population of the environs of the plants have been carried out for many years. They have taken into account both radiation exposures from external sources and those arising from incorporated radioactive substances. Photographic film detectors, pocket ionization chambers, and photoluminescent and thermoluminescent dosimeters are employed for dosimetry of personnel and environmental monitoring. Incorporation measurements are performed with whole-body counters and sensitive excretion measurements. The environmental exposure resulting from potentially radioactive gaseous effluents is determined by means of sensitive emission measurements and comprehensive meteorological assay programs. Moreover, data are available on the radioactivity of the liquid effluents discharged. All these mea-

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surements by far exceed the requirements of routine health physics. The evaluation has shown that the external exposure of the individual groups of persons due to nuclear facilities amounts to only a few percent each of the dose levels permitted by legislation and by the International Commission on Radiological Protection (ICRP). The radiation burden due to incorporation is small relative to the dose from external radiation exposures. These findings were not changed significantly by individual cases both of internal and external exposure in which the permissible levels were reached or exceeded. This means that neither a major expansion in nuclear technology, which would affect an increasing part of the population, nor further administrative restrictions, for which there is no reason in the light of the present knowledge of medicine and biology, require additional technical measures of protection to be taken. However, on the other hand, this fact must not induce a restriction of monitoring, because only a comprehensive program will create the psychological and disciplinary conditions that attributed to the low radiation doses. (auth)

52062 (A/CONF.49/P–429) BASIC RESULTS OF THE WORK ON DEVELOPMENT OF THE RADIATION SAFETY SYSTEM IN THE USSR. Burnazyan, A. I.; Gorodinskii, S. M.; Il'in, L. A.; Kozlov, V. M.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, [Moscow]). Jun 1971. 19p. (CONF-710901–355). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Radiation protection standards in the USSR are implemented by legislation. The basic concepts of the standards, based on the recommendations of the ICRP, for the protection of personnel in industry and research using radiations and the general population are reviewed. (C.H.)

52063 (A/CONF.49/P–550) EXPOSURE OF THE POPULATION IN CZECHOSLOVAKIA TO IONIZING RADIATION: CONCLUSIONS FOR RADIATION PROTECTION. Kunz, E.; Brezik, Z.; Brezikova, D.; Chysky, J. (Institute of Hygiene and Epidemiology, Prague. Institute of Radiation Hygiene, Prague). May 1971. 20p. (CONF-710901–239). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Radiation protection system appropriate to actual risk requires knowledge or qualified estimate of exposure of population groups from different radiation sources. Studies performed in Czechoslovakia disclose that x ray diagnostics is the predominant source of exposure. In 1966 the genetically significant dose amounted to 37 mrad and the per capita bone marrow dose was 70 to 190 mrad. Practically every citizen is exposed, with individual doses differing considerably. To estimate exposure from radioactive fallout, studies were made on food contamination by ^{90}Sr and ^{137}Cs. Samples of milk collected weekly and of selected foodstuffs in selected localities were analyzed. Contamination of milk was found not to be an accurate indicator of contamination of food as a whole. Representative data on exposure were gained by measurements of ^{90}Sr in samples of human bones. Mean bone doses did not exceed several mrad per year. Systematic monitoring of external exposure and selective determination of internal contamination in professionally exposed persons disclosed low mean values. Analysis of the data points to different potential risk of higher exposures in various types of work with radiation sources. The other sources contribute to population burden to a much lesser extent, some of them causing relatively higher exposure in restricted population groups. (auth)

52064 (A/CONF.49/P–659) BIOSTATISTICAL INVESTIGATION OF LUNG CANCER INCIDENCE IN SOUTH AFRICAN GOLD/URANIUM MINERS. Basson, J. K. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)); Wyndham, C. H.; Heyns, A. J. A.; Keeley, W. H.; (and others) (Chamber of Mines, Johannesburg (South Africa)). May 1971. 16p. (CONF-710901–312). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A study was undertaken to determine whether, as a result of exposure to radon-222 daughters arising from the presence in gold ores of low concentrations (0.015 to 0.075 per cent U_3O_8) of uranium, the incidence of lung cancer amongst South African gold miners is greater than it is in the male population as a whole. A random sample of 1100 men was drawn from the total of 227,000 miners registered by the Chamber of Mines up to the end of 1967, and the cumulative exposure for each man was calculated as the product of the shifts worked underground and the relevant concentration of radon daughters. On the basis of surveys made in twelve typical mines, estimates of radon concentrations expressed in Working Levels were assigned to each of the 119 mines concerned. The average cumulative exposure over the period 1960-7 was 35.8 Working Level Months. From the number of deaths due to bronchogenic carcinoma and the estimated population at risk (using an expansion factor 227,000/1100 = 206) the crude death rates per 10,000 miners per year were calculated for the eight-year period. The average annual death rate due to lung cancer among gold miners in South Africa was found to be 2.96 per 10,000 as compared with 2.88 for the general population. It was concluded that the death rate from lung cancer among gold miners has not been increased by radon exposure. (auth)

52065 (A/CONF.49/P–800) ENVIRONMENT MONITORING PROGRAMME AT THE A.A.E.C. RESEARCH ESTABLISHMENT, LUCAS HEIGHTS. Watson, G. M. (Australian Atomic Energy Commission). May 1971. 20p. (CONF-710901–334). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The environmental monitoring program at the Australian Atomic Energy Commission's Research Establishment near Sydney during the past ten years is described. The establishment has a staff of 1200, and its major research facility is a 10 MW(th) heavy water moderated and cooled materials testing reactor, which is also used for extensive radioisotope production. Possible sources of environmental contamination are atmospheric from isotope production facilities and reactor tritium, estuarine from the discharge of low-level liquid effluent to a tidal stream, and leaching from a burial ground for low-level solid wastes. Expressed as a fraction of I. C. R. P.-derived limits, the levels of environmental activity have been found to be trivial. (auth)

52066 (A/CONF.49/P–824) EXPERIENCE IN OPERATIONAL HEALTH PHYSICS AND DEVELOPMENT OF MONITORING TECHNIQUE IN JAPAN. Fukuda, Seiji; Yoshida, Yoshikazu (Japan Atomic Energy Research Inst., Tokyo). May 1971. 23p. (CONF-710901–346). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Experience in operational health physics in the main nuclear facilities of the Japan Atomic Energy Research Institute (JAERI) is described and measures used to solve the problems of radiation monitoring are described. Unusual occurrences associated with radioactive contamination and personnel exposure increased in the 1964 to 1965 period, when large facilities such as research reactors, radiochemical laboratories, radioisotope production facilities, and accelerators started full-scale operations. However, such occurrences were decreased mainly by using an improved radiation monitoring system and technique after 1965. The development of a monitoring technique for airborne radioactive materials, such as radioiodine in chemical laboratories and airborne tritium in heavy water reactors, and of methods using portable instruments for evaluating the neutron dose equivalent at JAERI is described. In addition, the development of lung monitors using a NaI scintillation detector or a proportional counter is reported. (auth)

52067 (A/CONF.49/P–851) RADIATION WORKERS AND THEIR PROTECTION. (International Labour Office, Geneva (Switzerland)). Aug 1971. 18p. (CONF-710901–467). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Data are summarized from a world-wide survey on the annual radiation dose received from various sources by the human population during 1970. Data on a total of more than 796,000,000 persons showed the mean annual dose to be 0.15 mrems/year. Persons in industrialized countries, with a total population of more than 357,000,000, received an average dose of 0.3 mrems/year/person of ionizing radiations from all sources, including medical and occupational exposures. (C.H.)

52068 (COO–1500-18) FIELD STUDY OF PERSONAL AIR SAMPLING AND BIOASSAY TECHNIQUES FOR MONITORING RADON PROGENY INHALATION EXPOSURES OF URANIUM MINERS. Schiager, Keith J. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). [nd]. Contract AT(11-1)-1500. 12p. (CONF-700505–27). Dep. NTIS.

From second congress of the international radiation protection association; Brighton, England (3 May 1970).

A preliminary report of a field study of several methods of monitoring radon progeny inhalation exposures to uranium miners is presented. The feasibility of evaluating miners' exposures through bioassay techniques was investigated by comparing the results obtained using these techniques with results obtained using personal TLD monitoring systems carried by the miners. The results obtained using both of these techniques were then compared with spot air samples collected weekly in the work areas and corrected for employee time in these areas. On the basis of the examples cited, it was not possible to determine whether one method of monitoring is more valid than another. (E.R.B.)

52069 (JAERI-13591) EVALUATION OF SURFACE ABSORBED DOSE FROM β-RAYS. Bingo, Kazuyoshi (Japan Atomic Energy Research Inst., Tokai). Jun 1969. 35p. NTIS (U. S. Sales Only).

The surface absorbed dose by soft tissue per unit fluence of β rays was estimated by means of the Bethe–Bloch formula for rate of energy loss using the theoretically calculated energy spectrum of β rays. It was found that the surface absorbed dose per unit fluence of β rays was nearly equal to that per unit fluence of mono-energetic electrons having the energy 0.17 E_{max}, where E_{max} is the maximum energy of the β rays. The approximate value of the surface absorbed dose per unit fluence of β rays was found to be given by $(4.1\ E_{max}^{-0.76} + 0.8\ E_{max}^{0.5}) \times 10^{-8}$ rad/(n/cm^2) ($0.01 < E_{max} < 5$, MeV unit). On the other hand, the surface absorbed dose per unit fluence of β^+ rays was found to be nearly equal to that per unit fluence of monoenergetic positrons having the energy 0.3 E_{max}, and to be given by $(2.5\ E_{max}^{-0.8} + 1.1\ E_{max}^{0.5}) \times 10^{-8}$ rad/(n/cm^2) ($0.1 < E_{max} < 3$, MeV) approximately. (auth)

52070 (LA-tr-71-70) EXPERIENCES IN THE MONITORING OF AIR CONTAINING RADIOACTIVE AEROSOLS. Koenig, L. A. Translated for Los Alamos Scientific Lab., N. Mex., from Atompraxis; 16: 320-4(1970). 13p. Dep. NTIS.

Experience at the Nuclear Research Center, Karlsruhe, in the field of aerosol monitoring is summarized. Measurements obtained in two incidents are described. In the first incident, water damage resulted in a contamination which spread about two Curies of alpha activity over an area of 800 m^2. In the second incident, leakage from a plutonium-containing fuel rod resulted in a dust-like contamination in a larger space (several thousand m^2). The various procedures for air monitoring and the determination of the ratio of the volume air contamination to the surface contamination are described. (W.H.K.)

52071 (N-71-24257) MEASUREMENT OF RADIATION EXPOSURE OF ASTRONAUTS BY RADIOCHEMICAL TECHNIQUES. Quarterly Research Report, July 6–October 4, 1970. Brodzinski, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 15 Oct 1970. 13p. (NASA-CR-118027; BNWL-1183-6). NTIS.

The elemental concentrations of the fecal samples from the Apollo 12 and 13 missions are being determined by neutron activation and gamma ray analysis of the induced radionuclides. Packets of the capton used as the outer thermal coating of spacecraft were proton irradiated at 108, 375, and 600 MeV. The ^{7}Be and ^{22}Na excitation functions from this material are reported. The cross sections of these induced radionuclides are compared to the previously measured activities in the skin from the Apollo 8 and 12 mission spacecraft. The concentration of ^{210}Po in a piece of the outer thermal coating of the Apollo 12 spacecraft was determined. The origin of the ^{210}Po is assumed to be the escaping decay products from the uranium in the moon. The average lunar surface uranium concentration of 0.061 ppM determined in this manner appears to be too low by a factor of approximately 6 or 7 based on measurements of moon rocks and finds returned by the Apollo 11 and 12 missions. The construction of a semi-portable, multipurpose gamma ray spectrometer system is proposed. Suggested applications and a description of the high-efficiency, low background whole-body counter and sample counter combination are given. (auth)

52072 (RT/PROT-(71)10) SURVEY DOSIMETRY IN A FIELD OF 1200 CURIES OF GAMMA RAYS. Scarpa, G.; Moscati, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 14 Apr 1971. 36p. (In Italian). Dep. NTIS (U. S. Sales Only).

Methods and results are described for a dosimetric study of the radiation field existing in the useful beam of a gamma irradiator. The unit was intended for radiobiological experiments and was equipped with a 1200 Ci ^{60}Co source. The measurements were carried out using a thimble-shaped, air-walled ionization chamber; the radiation field was searched in points distributed according to a space lattice pattern, with a 50 cm mesh. As a result, isoexposure curves were plotted and the beam limits were defined. Furthermore, the study allowed the source positioning inside the unit to be improved and the source shape and size to be directly visualized by means of a "pin-hole" camera technique. (auth)

52073 (UCRL-20262) MEASUREMENT OF INDUCED ACTIVITY TO ESTIMATE PERSONNEL RADIATION EXPOSURES RECEIVED FROM ACCELERATOR BEAMS. Miller, A. J.; Patterson, H. W. (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1971. Contract W-7405-eng-48. 24p. (CONF-710710-9). Dep. NTIS.

From sixteenth annual Health Physics Society meeting; New York, N. Y. (12 Jul 1971).

A method was developed to estimate the dose received by personnel accidentally exposed to an accelerator particle beam. The radiation dose estimate is based on measurement of the gross induced activities, primarily ^{11}C, resulting from nuclear interactions of the particle beam with the body tissues of the exposed individual. The activities are measured with a portable NaI crystal γ-ray scintillation detector. To achieve maximum sensitivity and counting statistics, the activity measurements are made in a low-background counting enclosure very soon after exposure. Doses were estimated by exposing two tissue-equivalent phantoms, one simulating an arm and the other simulating a torso, to particle beams (protons, π^+ mesons, and neutrons) of various energies. Results indicate that independent of the part of the body exposed, the beam size, or the beam energy from 50 MeV to $\approx$6 GeV, the actual dose can be estimated within a factor of 2. Under favorable conditions the lower limit of sensitivity in estimating the dose is less than 1 rem. (auth)

52074 COMPARISON OF THE DOSIMETRIC CHARACTERISTICS OF THE MEDICAL PROTON BEAM OF THE LABORATORY OF NUCLEAR PROBLEMS OF THE UNITED INSTITUTE OF NUCLEAR RESEARCH (LJaP OIJaI) IN STATIONARY-FIELD IRRADIATION AND QUANTUM IRRADIATION. Vainberg, M. S.; Komarov, V. I.; Savchenko, O. V. (Inst. of Experimental and Clinical Medicine, Moscow). Radiobiol.-Radiother.; 11: No. 1, 1-9(1970). (In German).

The design features of the medical proton beam facilities of the Laboratory of Nuclear Problems of the United Institute of Nuclear Research, Dubna, USSR, are described. The depth-dose characteristics of the 160 MeV proton beam were compared to those of 160 MeV x radiation, bremsstrahlung from a betatron with maximum energy of 20 MeV, ^{137}Cs γ, and ^{60}Co γ. Isodose curves are presented. (C.H.)

52075 INFLUENCE OF GIRTH AND PELVIC BONES OF THE PATIENTS ON DOSE DISTRIBUTION IN MULTIAXIAL PENDULUM IRRADIATION OF GYNECOLOGICAL TUMORS. Richter, J. (Deutsche Akademie der Wissenschaften, Berlin). Radiobiol.-Radiother.; 11: No. 1, 17-25(1970). (In German).

For the biaxial and four-axial methods of x-irradiation the dependence of dose distribution on the cross-section of the patient and on the embedded bone was examined. If the dose distribution used was determined on the basis of bone density errors of 9% may arise if these dose distributions are used for different patients. In a standardized dose distribution for homogenous tissue and an irradiation time valid for homogenous tissue errors up to 20% may occur. The total dose which is characterized by the volume dose is approximately the same for both methods of irradiation and depends on the cross-section of the patient. (auth)

52076 RADIATION EXPOSURE OF THE PHYSICIAN AND OF THE MEDICAL STAFF IN THE HANDLING WITH ^{198}Au SEEDS. Bartolmaes, H.; Glaser, F. H.; Schmidt, E. (Martin-Luther-Univ., Halle, Ger.). Radiobiol.-Radiother.; 11: No. 6, 705-11 (1970). (In German).

The annual radiation exposure of medical personnel engaged in the implantation of ^{198}Au seeds is reported. Dose measurements performed during the treatment of 200 patients gave evidence of the fact that ^{198}Au in the use of high total activities the dose to the physician and of the staff was kept within the permissible legal limits. This was also true of the care of patients who had to stay in the hospital until the activity was decreased. (auth)

52077 DOSIMETRY FOR A BIOLOGICAL IRRADIATION FACILITY AT A THERMAL REACTOR. Zarand, P. (National Research Inst. for Radiobiology and Radiohygiene, Budapest); Makra, S.; Santha, A. Phys. Med. Biol.; 16: No. 3, 479-88(Jul 1971).

A description is given of an irradiation cavity in which small biological objects can be exposed to mixed neutrons and γ-rays. The neutron/gamma ratio can be varied by the use of easily replaceable filters. The neutron spectrum and kerma were measured by activation techniques and the γ-ray dose measured by neutron-insensitive thermoluminescent dosemeters. The fast neutron flux could be varied between about 10^8 and 10^9 n cm^{-2} s^{-1} and the fast neutron kerma-rate between 10^3 and 10^4 rad/h, while the γ-ray dose-rate can be varied between 10^2 and 10^4 rad/h. The kerma due to thermal neutron contamination is less than 1% when B_4C filters are used. (auth)

52078 PHYSICAL CHARACTERISTICS OF FAST NEUTRON BEAMS. Bewley, D. K. (Hammersmith Hospital, London). Eur. J. Cancer; 7: No. 2-3, 99-104(May 1971).

From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

The physical properties of fast neutrons in relation to the biological effects are discussed and a comparison is made with the analogous properties of photons. Changes in radiation quality with neutron energy and with the establishment of secondary charged-particle equilibrium were more important than in the case of photons. Penetration of fast neutrons in tissue depended on the neutron energy. To match the penetration of ^{60}Co γ rays it was necessary to use 14 MeV neutrons at 1 m or more, or to use neutrons generated by at least 30 MeV deuterons on beryllium. Scattering of neutrons by tissue was of less importance than scattering of orthovoltage x rays. Gamma radiation is produced by interactions between neutrons and tissue and complicates the dosimetry. A biological dosimeter was used to check that depth-dose curves gave a correct representation of biological effect. Fast neutrons gave some degree of skin-sparing due to lack of secondary charged particle equilibrium on the surface. To match the degree of skin-sparing given by ^{60}Co γ rays it was necessary to use at least 50 MeV deuterons on beryllium. Energy absorption depended on hydrogen concentration and was a minimum in bone and a maximum in fat. The variation of biologically effective dose between different tissues and across the build-up zone was not necessarily proportional to the observed ionization. (auth)

52079 DOSIMETRY IN NEUTRON RADIOTHERAPY. **Rossi, H. H.** (Radiological Research Labs., New York). Eur. J. Cancer; 7: No. 2-3, 115-20(May 1971).
From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

The meaningful specification of patient dosage in neutron therapy requires, in addition to a statement of the absorbed dose of neutrons, an accurate assessment of the absorbed dose of gamma radiation, including both capture gamma radiation produced in a patient and any contaminant gamma radiation that accompanies the neutrons. In addition the dependence of RBE on neutron energy requires specification of radiation quality. Various methods of measuring absorbed doses of neutrons and gamma rays are considered and it is concluded that it should be possible to determine these quantities accurately enough for neutron therapy. The specification of radiation quality is more difficult, and it is suggested that it be characterized in terms of the incident neutron spectrum. (auth)

52080 RADIOTHERAPEUTIC REQUIREMENTS OF 14 MeV FAST NEUTRON BEAMS WITH RESPECT TO DEPTH-DOSE AND COLLIMATION. **Duncan, W.; Greene, D.; Major, D.** (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Eur. J. Cancer; 7: No. 2-3, 129-34(May 1971).
From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

A method of estimating the level of stray radiation outside the geometric beam of 14 MeV neutron generators is suggested as compared with the stray radiation from telecobalt γ units and 250 kV x ray machines. The level of whole-body neutron radiation which will have to be tolerated by patients was considered to be within acceptable limits. (auth)

52081 EXPOSURE RATE AT THE SURFACE OF SYRINGES CONTAINING RADIOACTIVE MATERIAL. **Husak, V.** (University Hospital, Olomouc, Czech.). J. Nucl. Med.; 12: No. 8, 574-5 (Aug 1971).

A knowledge of the exposure at the surface of syringes containing radioactive solutions lets one assess the probable magnitude of dose to the fingers of persons handling the syringes. It is shown that the surface exposure rate can easily be determined theoretically for any syringe and any radionuclide considered. (TSS)

52082 NEW MEASUREMENT TECHNIQUES IN PERSONNEL DOSE MONITORING. **Regulla, D.** (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Neuherberg, Ger.). Radiologe; 11: No. 2, 78-81(1971). (In German).

Modern solid-state dosimeters (photoluminescent, thermoluminescent) have good dosimetric properties. These dosimeters, in combination with conventional film dosimeters, make suitable combination dosimeters in which the function of the film dosimeters is supplemented by reliable and integral readings of solid-state dosimeters which are also valuable in the boundary region. Prompt determinations of personnel dose for medical first-aid measures in case of accidents and catastrophic situations are possible by use of solid-state dosimeters. Some solid-state dosimeters are described as well as their use as personnel dosimeters. (INIS)

52083 SPECIAL FEATURES OF DEPARTMENTAL SANITARY RULES FOR WORKING WITH NATURAL RADIOACTIVE MATERIALS IN THE RARE METAL INDUSTRY. **Vershinin, N. V.; Denisov, A. F.; Elovskaya, L. T.; Moiseitsev, P. I.; Sukhov, G. V.** Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 22: 331-4(1968). (In Russian).

The mining and processing of rare metal ores frequently involves exposure of personnel to radiations emitted by significant quantities of Th and U, which are incorporated in the crystalline lattice of the minerals. Storage rooms for radioactive tailings may emit radiation doses of 2000 to 3000 μR/hr. During the mining and fabrication of ores containing up to 0.05% Th + U, air contamination by radioactive dusts in operating rooms was not observed to exceed concentration limits established for industrial uses. Permissible limits of concentration for U and Th are not exceeded when their content in the material processed is less than 0.2%. This level may be taken as a threshold value for air contamination by U and Th. Hazards from the release of radioactive gases, such as Rn, which depend upon the nature of the industrial operation, the temperature, and the state of aggregation, are considered. The radiation safety factor will depend upon the Rn activity released, the volume of the room, and the frequency of air replacement per hour. The limits of surface contamination depend on the U and Th content of the processed material. Factors that contribute to the radiation protection of personnel, such as the size of the working rooms, ventilation, and dosimetric control are briefly considered. (K.S.W)

52084 DETERMINATION OF MAXIMUM QUANTITY OF POTASSIUM EXERTING NEGLIGIBLE RADIOMETRIC INFLUENCE ON VEGETABLE SAMPLE ACTIVITY MEASUREMENT. I. CRITERIA OF DETERMINATION OF THE QUANTITY OF PERTURBING RADIONUCLIDES. **Zaduban, M.** (Safarik-Univ., Kosice, Czech.). Isotopenpraxis; 7: No. 4, 142-4(Apr 1971). (In German).

Radiometric influence of naturally unstable nuclides on activity measurement carried out on biosphere samples is shown. With regard to the fact that the presence of such nuclides may exert radiometric influence, there is being discussed the possibility of settling measuring conditions rendering negligible the counting rate of the perturbing nuclides with corresponding correction becoming superfluous when measuring the activity of some other nuclide. The present report describes three methods of determination of the counting rate of perturbing nuclides. (auth)

52085 IMAGE INTENSIFIER IN HIP PINNING. A COMPARISON WITH CONVENTIONAL RADIOGRAPHY. **Breidahl, P.** (Royal Perth Hospital, Shenton Park, Australia). Australas. Radiol.; 15: No. 2, 176-(May 1971).

No difference in results was observed by comparing control of orthopedic surgery using radiographic filming with control by image intensification and television. Radiation dosage required for the two techniques was shown to be greater for the image intensifier if screening totaled more than 7½ mA/min. and as the average dose is assessed at 45 mA/min. this technique will generally result in greater dosage than conventional radiographic control. (Australia)

52086 OVARIAN RADIATION DOSAGE DURING HYSTEROSALPINGOGRAPHY. **Shirley, Robert L.** (Harvard Medical School, Boston). Fert. Steril.; 22: No. 2, 83-5(Feb 1971).

A functional clinical measurement of ovarian radiation dose during hysterosalpingography has been performed. With fluoroscopy and spot films the mean radiation was about 1000 millirads. By use of the simpler two-film technic the mean dose was found to be 130 millirads. (auth)

52087 DOSIMETRY FOR SEEDS OF DAHLIA AND DIOSCOREA IRRADIATED WITH 1.0 MeV ELECTRONS. **Reyes L., J.** (Univ. Nacional de Mexico, Mexico City); **de la Teja, O.; Villalobos-Pietrini, R.** Rev. Mex. Fis.; 19: FA122-33(1970).

A method is described for calculating the absorbed dose for seeds of Dahlia and Dioscorea irradiated with 1.0 MeV electrons. The design of an irradiation facility for producing a uniform depth-dose distribution through the samples is described. (auth)

52088 PROTOCOL FOR THE DOSIMETRY OF X AND γ RAY BEAMS WITH MAXIMUM ENERGIES BETWEEN 0.6 AND 50 MeV. Phys. Med. Biol.; 16: No. 3, 379-96(Jul 1971).

A critical assessment of practical methods for determination of absorbed dose as well as specific recommendations for the dosimetry of ^{137}Cs and ^{60}Co γ-ray beams and x-ray beams with peak energies between 2 and 50 MeV is presented. Dosimetric methods and calibration depths are considered. Primary phantoms of water and secondary phantoms of polystyrene or acrylic plastic are recommended. Absorbed dose calibration methods are considered including the calibrated cavity, determination of dose from in-air measurement of exposure, the Fricke-ferrous sulphate dosemeter, and the absolute (Bragg-Gray) cavity ionization chamber. General considerations in the calibration of high energy x- and γ-ray therapy equipment including frequency of calibration are given. (UK)

Radiation Protection

Refer also to abstracts 52154 and 52489.

52089 (A/CONF.49/P–142) EXPERIENCE DEVELOPED IN MONITORING AND CONTROL OF RADIATION IN THE U.A.R. Mahmoud, K. A.; Morsy, S. M.; Hanna, I. R.; (and others) (Atomic Energy Establishment, Cairo (Egypt)). May 1971. 18p. (CONF-710901–81). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Radiation monitoring and protection programs in Egypt are reviewed. Thermoluminescent glass detectors, modified film badges, and cadmium-shielded LiI thermoluminescent detectors were investigated for measurements of thermal and intermediate neutron dose and intermediate neutron dose rate. The manganese bath technique is used for the calibration of neutron sources. The effects of manganese sulphate concentration and bath volume were investigated. Hydrocarbons and chlorohydrocarbons were studied as chemical dosimeters to measure γ dose in mixed n, γ fields. The effects of temperature and humidity on film response to γ radiation were also investigated. A theoretical formula for detector efficiency was derived for the calibration of larger volume γ sources. Monitoring of internally-deposited γ emitters is conducted by whole-body counting using the photopeak efficiency technique. Problems of evaluation of counter response were solved theoretically. The performance of NaI scintillation detectors was investigated for the assessment of plutonium body-burden and depth distribution. A method for the assessment of α-emitters in urine was developed that uses adsorption on dextrangel. Surveys of environmental ^{90}Sr and ^{137}Cs in fallout, water, soil, food chain, and man are conducted annually. Studies on the effects of low-dose radiation on man and on experimental animals showed that maximum permissible exposure levels should be reconsidered for radiation workers with a history of Schistosoma infections. (auth)

52090 (A/CONF.49/P–439) GENERAL RESULTS AND PURPOSES OF THE MEDICAL SUPERVISION OF THE PERSONS, WORKING WITH THE SOURCES OF IONIZING RADIATION, IN THE USSR AT THE PRESENT TIME. Letavetz, A. A.; Guskova, A. K.; Larskii, P. P.; Moiseitzev, P. I.; (and others) (Ministry of Health, USSR). Jun 1971. 32p. (CONF-710901–382). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The results of 15-years of observations in the USSR are reviewed that show that, at present the levels of irradiation, in routine conditions of the personnel of scientific and medical establishments, reactors, particle accelerators, and industrial radiography are from 0.5 to 0.1 of the maximum permissible radiation dose. Data on 6000 persons, in comparison with adequate control groups, have been subjected to a detailed dynamic clinical physiological examination. Legislation relevant to radiation protection of personnel in the USSR is reviewed. (auth)

52091 (A/CONF.49/P–523) HEALTH, SAFETY, AND LEGAL ASPECTS OF NUCLEAR ENERGY IN THE FIELD OF RADIATION PROTECTION IN PORTUGAL. Pistacchini Galvao, J.; Vaz Carreiro, A.; Ortins de Bettencourt, A.; Vaz, A. Nazare; (and others) (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). Jun 1971. 19p. (In French). (CONF-710901–489). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Radiation protection in Portugal is described. The methods used in the protection of medical personnel occupationally exposed and the methods used for the evaluation of biological effects are reported. The development of new methods for biological dosimetry is also reported. The results of surveys carried out from 1965 to 1970 in the field of dosimetry of personnel occupationally exposed to external radiation in different branches of activity, such as industry, hospitals, private clinics, research centers, mines, and atomic energy centers are presented. The evolution of the installation licensing is reported. Methods used for monitoring radioactivity in effluents of the installations in general, as well as the established program for special cases such as the presence of nuclear ships in Portuguese harbours and radioactive waste disposal in the Atlantic Ocean are described. The results of recent work carried out in environmental monitoring radioactive pollution, in particular studies concerned with the contamination of milk by ^{90}Sr are summarized. (auth)

52092 POSSIBILITIES OF TELEDOSIMETRY IN RADIATION PROTECTION. Babor, R. (Gesellschaft fuer Strahlen- und Umweltforschung mbH, Neuherberg, Ger.). Radiologe; 11: No. 2, 81–5(1971). (In German).

Possibilities of practical radiation protection in medical x ray institutes are presented. They clearly indicate how patient and physician dose can be reduced by means of economic teledosimetry on the basis of film method, occasionally supplemented by thermoluminescence dosimeters. (INIS)

52093 PROTECTION FROM RADIOACTIVE CHEMICALS. Dancer, G. H. C. (Radiochemical Centre, Amersham, Eng.). Process Biochem.; 6: No. 6, 19–20(Jun 1971).

When working with radioactive chemicals there is a most vital need to control the exposure to external radiation and to prevent the risk of ingestion or inhalation of radioactive material. Precautions involve speeding up the experimental operation, keeping the distance from the material to a maximum, use of shielding, and monitoring. Minimum quantities only of radioactive material should be used, and containment, cleanliness, protective equipment, and hygiene are all essential. (auth)

52094 PREVENTION OF RADIATION RISKS IN HOSPITALS. NOTE 1. RADIOACTIVE ISOTOPES: CHARACTERISTICS AND PROBLEMS OF PROTECTION. Dall'Acqua, G. F.; Lostia, G. B. (Univ., Turin). Ig. Mod.; 62: 651–64(1969). (In Italian).

The physical characteristics of the radioisotopes commonly used in medical diagnosis and the biological effect produced by them are reviewed. It is concluded that the organization of a service destined to employ radioactive substances in a hospital must be the outcome of careful studies, carried out in collaboration with experts in the fields of health physics and radiology. (auth)

52095 CONTROL OF PERMISSIBLE DOSE TO WORKERS EXPOSED TO IONIZING RADIATION. Cerovac, H. Arh. Hig. Rada Toksikol.; 19: 315–21(1968). (In Serbo-Croatian).

The possibility of estimating the radiation dose of a worker exposed to ionizing radiation from data obtained by film dosimetry is discussed. Data are tabulated for the years 1962 to 1967 on the number of Yugoslavian workers exposed and the doses received (absolute, percentage of permissible, and cumulative), broken down by type of work, e.g., industrial radiography, medical work, and other types. (TTT)

52096 PROTECTION OF THE PATIENT IN RADIONUCLIDE INVESTIGATIONS. A REPORT PREPARED FOR THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION AND ADOPTED BY THE COMMISSION IN SEPTEMBER 1969. ICRP Publication 17. Oxford; Pergamon Press (1971). 88p. Pound 2.00.

The report considers the subject in the sections; choice of nuclide and compound (half-life, energy of emission, type of emission, chemical form, availability of substitute elements or compounds, and requirement of test), organ of reference, estimates of the dose per unit of activity administered, recommendations on the clinical use of radionuclides (categories of subjects, basic principles, adult patients, pregnant patients, children, normal controls, repeated investigations, and the use of blocking agents), and notes on further metabolic information required for dosimetry. An appendix tabulates each nuclide separately and data are separated according to the different routes of administration and to the different compounds and pharmaceuticals used. For each mode of administration the dose received by the principle organs or tissues is given together with the typical activity used in the investigation. (auth)

52097 COMPARATIVE EVALUATION OF RADIOBIOLOGICAL EFFECTS OF VARIOUS TYPES OF PARTIAL PROTECTION. Grigor'ev, Yu. G.; Nevskaya, G. F.; Abramova, G. M.; Ginsburg, E. V.; Kalandarova, M. P. Kosm. Biol. Med.; 4: No. 3, 40–5(May-Jun 1970). (In Russian).

The results of studying the efficiency of partial-body protection of dogs irradiated with 250 MeV protons at a minimal absolutely lethal dose (350 rad) are given. With this purpose paraffin blocks were used that shielded 15% of the body–head, chest, upper and lower portions of the abdomen, the pelvic region, or hind legs. The partial protection of any portion of the body appeared effective and all experimental animals survived. The effect was

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most pronounced when the chest and pelvis were shielded. A distinct relationship between the effect of the partial-body protection and the amount of the shielded bone marrow was revealed. (auth)

52098 TEXTILES TREATED AGAINST CONTAMINATION FROM RADIOACTIVE MATERIALS. Shimazaki, K.; Hasegawa, T.; Nakatomi, S.; Nagai, K. Canadian Patent 870,553. 11 May 1971. Priority date 7 Aug 1962, Japan.

A textile product affording protection from radiation was obtained by impregnating a fibrous material with a solution of a resin and an organic polyaminocarboxylic acid or salts thereof and then drying the material. The textile thus obtained has a high molecular weight substance impregnated in its fibers that is formed by curing the resin in the presence of carboxylic acid or salt. The resulting substance has protective properties against radiation, especially fallout. (Canada)

Safety Procedures

Refer also to abstracts 51577 and 53407.

52099 RECOMMENDED FIRE PROTECTION PRACTICE FOR FACILITIES HANDLING RADIOACTIVE MATERIALS. NFPA No. 801 1970. Boston; National Fire Protection Association (1970). 30p.

The handbook discusses facilities that handle radioactive materials in relation to the problems posed in fire prevention and protection. The following general topics are included in the discussion: sources of radiation—nature of the fire problem; arrangement of facilities handling unsealed radioactive materials; service facilities; equipment for handling and processing radioactive materials; and protection against fire and explosion. References to related books and documents are included. (E.R.B.)

Legal Aspects

Refer also to abstracts 52275, 52286, and 53923.

52100 (A/CONF.49/P–400) LEGAL PROBLEMS OF INTERNATIONAL DANGER PROTECTION AND OF INTERNATIONAL EMERGENCY ASSISTANCE IN THE CASE OF RADIATION ACCIDENTS. Pelzer, N. (Goettingen Univ. (West Germany)). Apr 1971. 14p. (CONF-710901–142). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Nuclear accidents involve the risk of widespread international damage because of the special characteristics of radioactivity and the theoretically possible vast extent of the damage. It is therefore not only in the interest of the state in which the accident occurred to check the damage quickly and effectively, but in the case of major accidents this is also generally in the interest of the neighbouring states. International emergency assistance activities in the case of natural catastrophes and other such major disasters have proved that international solidarity is such that assistance can be provided without special agreements, but such spontaneous action without binding legal basis is obviously problematical. The present international treaty laws, international customs, and the national laws of important individual states are examined as to whether, and to what extent, international emergency assistance and danger prevention across national borders are admissible or are required by law. It is concluded that present laws do not offer sufficient possibilities to insure the necessary international catastrophe protection. Models for a multi-lateral agreement are presented. The effectiveness of multi-lateral standardisation of the licensing prerequisites for nuclear installations and of other nuclear activities for the prevention of nuclear accidents is considered. (auth)

52101 (A/CONF.49/P–567) EFFECT OF INTERNATIONAL COOPERATION IN THE ARGENTINE NUCLEAR PLAN. AN INTERESTING EXPERIENCE FOR THE DEVELOPING COUNTRIES. Alegria, J. A.; Coll, J. A.; Quihillalt, O. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). Jul 1971. 6p. (CONF-710901–440). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

International cooperation has played an important role in the preparation of the 10 years Argentine Nuclear Plan and is of fundamental importance in its execution. A detailed description of the assistance so far received is given and the reasons why it has to be adapted to the present conditions are shown. The experience obtained may be of interest for countries where nuclear energy has followed an evolution similar to that in Argentina, since it may enhance development by allowing them to obtain the maximum benefit of international cooperation. Concrete solutions to adapt the type of assistance to the attained degree of evolution are suggested and particular attention is paid to the way of meeting the requirements of a country that presents, as in the case of Argentina, an intermediate level of development in the nuclear field, and the need of starting the corresponding industrial stage. (auth)

52102 (A/CONF.49/P–624) ASPECTS OF FRENCH REGULATIONS IN THE NUCLEAR FIELD: BUILDING LICENCES, HEALTH PHYSICS, TRANSPORT RESPONSIBILITY INSURANCE. Bresson, G.; DeMoures, Y.; Lagorce, M. (Commissariat a l'Energie Atomique, Paris (France)); Hebert, J. (Electricite de France, Paris). Apr 1971. 16p. (In French). (CONF-710901–256). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The French ruling on nuclear plants and work under radiation brings up certain theoretical and practical problems including:—Building licenses—The procedure for the authorization and supervision of basic nuclear facilities covers permit applications, the establishment of records, and the delivery of a permit by decree. The permit carries general protection measures and special regulations governing the result achieved rather than the means employed, and gives the authorities the possibility of judging, before the plant is put into service, the steps taken by the user to guarantee its safety (safety report, report on the monitoring systems and the results of tests, working instructions, and ministerial permission).—Health physics—During the last few years a complete ruling governing work under radiation was issued. In the professional field it fixes the general principles of worker protection against ionizing radiations, safety norms, and supervision principles with special rules for large nuclear establishments. So far as the public is concerned, health physics is dealt with from several aspects (possession and use of artificial and natural radioelements, transport, atmospheric and water pollution, contamination of the food chain, and intervention in case of accident).—Transport responsibility insurance—Nuclear responsibility agreements have been unable to prevail over maritime agreements and insurers refuse to cover ship-owners for maritime law responsibilities from which they are not exempt. The future of nuclear transports is conditioned by the priority of nuclear law over maritime law. It is hoped that the joint work of maritime and nuclear experts will lead to this result. In addition, an arrangement of the Paris agreement should provide for better compensation to victims of a fuel transport accident in transit on national territory. (auth)

52103 (A/CONF.49/P–767) CIVIL LIABILITY OF THE OPERATORS OF NUCLEAR INSTALLATIONS AND INSURANCE AGAINST SUCH LIABILITY. Strohl, P. (European Nuclear Energy Agency, Paris (France)); Stein, R. M. (International Atomic Energy Agency, Vienna (Austria)). Jul 1971. 16p. (CONF-710901–450). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Several international conventions have established a special system of third party liability for operators of nuclear installations. The rules of nuclear law ensure the protection of the public and workers, while allowing for the development of this new industry. The role of international organizations such as the IAEA, ENEA, and EURATOM has been an important factor in the elaboration of the nuclear conventions. The four relevant Conventions are the Paris Convention on Third Party Liability in the field of nuclear energy (in force since 1968), the Vienna Convention on Civil Liability for Nuclear Damage, the Brussels Convention on the Liability of operators of nuclear ships, and the Convention of Brussels supplementary to the Paris Convention. The important features of these Conventions are: absolute and exclusive liability of the operator; limited liability; and insurance or financial security for this liability. The special system was intended to cover risks of an exceptional character that could not be covered appropriately by Common Law. It is important that definitions of nuclear installations and the scope of the Conventions should be harmonized. In countries whose legislation conforms with the nuclear conventions there are no serious difficulties over insurance and national pools of nuclear insurers have in many cases been set up. Insurance may be either per installation per period or per incident, and carriage is normally covered separately from insurance of the installation. The nuclear conventions do not affect international transport conventions and there is thus an exception to the exclusive liability of a nuclear operator. As a result maritime carriers demand an unlimited indemnity from the operator before agreeing to carry and this raises practical difficulties which a new draft maritime convention may help to overcome. A large number of countries have now achieved a measure of unification of nuclear law. Further ratification of the nuclear conventions would improve the situation still more. The nuclear conventions provide for unity of jurisdiction of courts dealing with claims and this has advantages for victims. (auth)

52104 STANDARDS FOR PROTECTION AGAINST RADIATION. Taylor, Lauriston. pp IV.1-18 of Nuclear Power and the Environment. Madison, Wis.; Univ. of Wisconsin (1970).

From Conference on nuclear power and the environment; Madison, Wis. (3 Apr 1970). See CONF-700415.

The development of early domestic and international radiation protection standards is discussed and the establishment of the ICRP, ICRU, and FRC is briefly described. The establishment of the JCAE and the NCRP is also discussed and their activities described. The need for further study of the relation between dose and effect especially in the low dose range is cited and a plea to refrain from panic reactions regarding radiation and the environment is made. (E.R.B.)

Medicine

Refer also to abstract 51703.

52105 UTILIZATION OF RADIOACTIVE MATERIALS IN THE FEDERAL REPUBLIC OF GERMANY. Vogg, H. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.); Gerve, A.; Gebauhr, W.; Goette, H. Atomwirt., Atomtech.; 16: No. 8-9, 478-84(Aug-Sep 1971). (In German).

A general survey is presented on the use of radioactive material in the FRG. Especially emphasized are its uses in medicine and pharmacology. In spite of technical improvement, insufficient use is made of such important tools as activation analysis and autoradiography. (H.B.G.)

Protective Substances

Refer also to abstracts 51962, 51978, 52042, 52089, 52181, 52198, and 52204.

52106 (A/CONF.49/P-257) RESTORATIVE EFFECTS OF POST-IRRADIATION TREATMENT WITH SUBSTANCES RELATING TO NUCLEIC ACIDS IN CELLS AND ANIMALS. Tsuchiya, T. (National Inst. of Radiological Sciences, Chiba (Japan)); Sugahara, T. (Kyoto Univ. (Japan)); Egami, N.; (and others) (Tokyo Univ. (Japan)). May 1971. 20p. (CONF-710901-98). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Cultures of Escherichia coli were given 20, 50, and 70 kR doses of x radiation and treated with nucleotides, nucleosides, guanosine-5′-monophosphate, and Nucleton. None of the chemicals showed any recovery effects on the survival of irradiated cells. The colony-forming method was used for studies on mouse L cells and Ehrlich ascites tumor cells. Following x irradiation the cultures were treated with nucleotides, monophosphates, and Nucleton. No recovery effect was observed in the colony-forming ability of the cells. Tumor-bearing mice were given 500 R doses of gamma radiation from a ^{60}Co source and injected intraperitoneally with DNA and various monophosphates. It was found that treatment with deoxyguanosine monophosphate caused a marked decrease in the incidence of chromosome breaks in tumor cells irradiated in the G$_1$ stage. Experiments with fish, Oryzias latipes, showed that nucleotides and nucleosides were not effective in restoring sublethal damage from x rays; however, Nucleton increased the 30-day survival rate of the fish. Following exposure to 700 R x rays mice were given RNA intraperitoneally; it was found that proliferation of hematopoietic cells was accelerated by treatment with RNA. Experiments with γ-irradiated mice showed that the 30-day survival was increased by DNA, RNA, Nucleton, and adenosine. (H.L.W.)

52107 QUANTITATIVE REGULARITIES OF THE REGENERATION OF THE BLOOD-FORMING TISSUE IN RADIATION CHIMERAS. Zaretskaya, Yu. M.; Kovalchuk, L. V. Radiobiol.-Radiother.; 11: No. 4, 457-64(1970). (In German).

Comparisons were made of the formation of blood in mice of the SVA strain who were protected after lethal x irradiation by syngenous and xenogenous bone marrow. In the course of 100 days the absolute count of myeloid, erythroid, and lymphoid types in the bone marrow of the femur, in the spleen, and in the axillary lymph nodes was determined at different periods after irradiation. The essential difference of the formation of blood in the heterologous chimeras was the great deficit of lymphoid types. It was concluded that the lymphoid atrophy which was not compensated by the bone marrow of the donor was the main cause of the death of the heterologous chimeras given transplants of bone marrow. (auth)

52108 EFFECT OF THE FOOD-JUICE OF THE QUEEN BEE (ROYAL JELLY) ON THE PERIPHERAL BLOOD AND THE SURVIVAL RATE OF MICE AFTER WHOLE-BODY X IRRADIATION. Wagner, H.; Doebler, I.; Thiem, I. (Humbolt-Univ., Berlin). Radiobiol.-Radiother.; 11: No. 3, 323-8(1970). (In German).

Examinations on the therapeutic effect of royal jelly, the food-juice of the queen bee, on mice following single x irradiated at 460 rad showed no unequivocal result. The unsaturated fatty acid separated from the food-juice of the queen bee did not show any effect. For the evaluation of the therapeutic effect, the peripheral white blood-picture and the survival rate of mice at 30 days were used. (auth)

52109 HYPOXIC PROTECTION AGAINST FAST NEUTRONS OF DIFFERENT ENERGIES: A REVIEW. Berry, R. J. (Churchhill Hospital, Oxford). Eur. J. Cancer; 7: No. 2-3, 145-52(May 1971).

From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

The differences between the dependence of Oxygen Enhancement Ratio (OER) on fast neutron energy in P-388 murine leukemia cells, and the lack of effect of neutron energy upon OER reported in human kidney-derived T-1 cells correlated well with differences in responses of the same cells to irradiation with monoenergetic track-segments of beams of deuterons and alpha particles whose ionization densities (LET) are known. Irradiation of the P-388 tumor cells with collimated beams of fast neutrons at 10 cm depth in a tissue-equivalent phantom yielded OER values lower than predicted by consideration of average LET and relatively independent of neutron energy. For irradiation from a planar array of neutron-emitting ^{252}Cf sources in a tissue-equivalent holder simulating a brachytherapy implant, the OER was disappointingly high (2.0), although still significantly lower than for irradiation with ^{226}Ra gamma rays in the same geometry. (auth)

52110 TESTOSTERONE AS A BONE MARROW STIMULANT IN IRRADIATED RATS. Horn, Y.; Robinson, E. (Hadassah Univ. Hospital, Jerusalem). Radiol. Clin. Biol.; 40: No. 2, 133-41(1971).

Testosterone propionate was used as a bone marrow stimulant before and after various doses of irradiation administered to rats. A determination of the leucocyte reserve was accomplished by injecting salmonella vaccine at the end of each experiment. The results show that the testosterone-treated animals irradiated with 100 or 400 rad had a better recovery of white blood cells than the controls. The drop after x ray was less apparent in the treated group. This phenomenon was more prominent in females than in their male counterparts. Better results were achieved in the groups treated with testosterone before irradiation than in those treated after. This finding showed dose relationship. (auth)

52111 SOME METHODS OF ACCELERATING THE HEALING OF FRACTURES IN RABBITS SUBJECTED TO CHRONIC GAMMA-IRRADIATION BY ^{60}Co. Khaitov, R. M. Eksp. Khir. Anesteziol.; 15: No. 6, 46-9(Nov-Dec 1970). (In Russian).

A series of four experiments was performed using 81 rabbits. Fifteen untreated animals served as controls. Sixty-six rabbits received 10 R of gamma radiation on alternate days until a total dose of 300 R was given. Injections of coamide were given to 23 of the irradiated rabbits and mumie was given to 15 of the irradiated rabbits. The second metatarsal bone was fractured in all animals. In the rabbits treated with radiation only, a marked deceleration and inversion of the post-traumatic bone regeneration were observed. The regeneration process was stimulated in irradiated animals that had received coamide and mumie. (auth)

52112 DIMETHYL SULFOXIDE PROTECTION OF HeLa CELLS AGAINST IONIZING RADIATION DURING THE GROWTH CYCLE. Zinberg, N.; Kohn, A. (Israel Inst. for Biological Research, Ness-Ziona. Tel Aviv Univ., Israel). Israel J. Med. Sci.; 7: No. 6, 719-23(Jun 1971).

HeLa cells were exposed to x rays in the absence or presence of dimethyl sulfoxide (DMSO) (10%). The dose modifying factor (DMF) for random nonsychronized cultures was 2.9. Synchronized HeLa cells were exposed to 300 and 700 R at various periods during the synchronization cycle in the absence and presence of DMSO. In unprotected cells, the most sensitive stage was G$_1$ and the most resistant stage at the end of S or beginning of G$_2$. Dose reduction factor of DMSO was determined by exposing cells in the G$_1$ and S phases to x irradiation in the range of 150 to 1,400

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R. The DMF of 10% DMSO for cells in early S was 4.7, in late S 3.6 and in G_1 4.5. (auth)

52113 DIMETHYL SULFOXIDE PROTECTION OF BONE MARROW CELLS OF MICE AGAINST X-RAY DAMAGE. **Zinberg, N.; Kohn, A. (Israel Inst. for Biological Research, Ness-Ziona. Tel Aviv Univ., Israel). Israel J. Med. Sci.; 7: No. 6, 713-18(Jun 1971).**

Mice treated by injection with dimethyl sulfoxide (DMSO) (4.5 g/kg) are protected against irradiation with 700 R. This protection is evident from the ability of bone marrow cells of irradiated mice to regenerate quickly (five vs. ten days postirradiation), with concomitant increased incorporation of radioactive thymidine. When bone marrow cells were irradiated in vivo and their viability determined by their retention of colony-forming ability, the dose modifying factor (DMF) was 1.4. When bone marrow cells were irradiated in vitro in the presence of 2.5% DMSO, the DMF was 1.7 and with 10% DMSO, it was 2.4. (auth)

52114 ORGANIC DISULFIDES AND RELATED SUBSTANCES. XXVIII. ANALOGS OF o-(2-PROTOAMINOETHYLDITHIO)BENZOATE AS ANTIRADIATION DRUGS. **Field, Lamar; Giles, Patton M. Jr. (Vanderbilt Univ., Nashville). J. Med. Chem.; 13: No. 2, 317-19(Mar 1970).**

The radioprotective effects of 0-(2-protaminoethyl-dithio) benzoate and analogous compounds on the survival of mice were investigated following γ and x irradiation. The preparation of some of the compounds is also described. (F.M.M.)

52115 TOXICITY AND RADIOPROTECTIVE PROPERTIES OF SEROTONIN-CONTAINING DEXTRAN DERIVATIVES. **Chernov, G. A.; Shevchenko, A. N.; Khomyakov, K. P.; Virnik, A. D. Farmakol. Toksikol.; 34: No. 3, 328-30(May-Jun 1971). (In Russian).**

Compounds containing serotonin joined to the dextran derivatives through azomethid and amide bonds possessed lesser toxicity polymers with the ion-bound serotonin. Dextran derivatives in which 5-oxytryptamine is combined through azomethine linkage produced a pronounced radioprotective action in mice. (auth)

52116 STRUCTURE-FUNCTION STUDIES OF THE AMINOTHIOL RADIOPROTECTANTS. EFFECT OF CARBON CHAIN LENGTH IN MERCAPTOETHYLAMINE HOMOLOGS: MAMMALIAN RADIOPROTECTION. **Grenan, Marie M.; Copeland, Edmund S. (Walter Reed Army Inst. of Research, Washington, D. C.). Radiat. Res.; 47: No. 2, 387-91(Aug 1971).**

The relation between chemical structure and radiation protection in mice has been studied for a series of aminothiols. The aminothiols used in this study were β-mercaptoethylamine (MEA) and its propyl, butyl, pentyl, and hexyl homologs. Mice were given equimolar quantities of these drugs 15 minutes before gamma irradiation at their $LD_{70(30)}$ (875 rads). At the radiation and drug doses employed, only MEA showed a radioprotective effect. This result is in marked contrast to those of previous studies in bacteria where pharmacological effects were avoided and only physical-chemical effects were studied. (auth)

52117 SELECTION OF RADIOPROTECTING SUBSTANCES BY SYSTEMATIC SCREENING, APPLICATION TO THE PRODUCT C_{511} HF (FROM THE HOUDE LABORATORY). **Frossard, H.; Perles, R.; Fatome, M.; Holleville, P. (Centre de Recherches du Service de Sante des Armees, Clamart, France). Radioprotection; 6: No. 2, 119-31(1971). (In French).**

Many substances have suspected radioprotecting qualities; a systematic sorting out allowed substances that have this property to be distinguished from those that have no such properties. This procedure is discussed. Various screening levels correspond to different criteria. Systematic screening indicated that the substance C_{511} HF might have favorable radioprotecting characteristics. A more detailed examination of the behavior of this substance revealed its radioprotecting qualities to be similar to the standard reference substance AET. Experiments on the weights of animal spleens confirmed this. The substance is not toxic and more easily used than AET. (auth)

Radiation Sickness and Injuries

52118 PRELIMINARY EXPERIENCES OF THE TREATMENT BY DMSO OF FIBROUS CHANGES OF THE SKIN AFTER PERCUTANEOUS RADIATION THERAPY. **Glaser, F. H.; Klaua, M. (Martin-Luther-Univ., Halle, Ger.). Radiobiol.-Radiother.; 11: No. 4, 399-404(1970). (In German).**

Aqueous solution of methyl sulfoxide (DMSO) (90%) was used percutaneously for the treatment of radioinduced changes of the skin after high dose conventional x ray deep therapy. Scarred indurations and fibrosis of the underskin became smaller and softer following DMSO treatment and persistent ulcerations of the skin were completely healed. The use of DMSO was generally well tolerated. (auth)

Radiodiagnosis

Refer also to abstracts 51847, 51862, 51865, 51866, 51876–51878, 51972, 51979, 52081, 52096, 52242, 52243, and 52252.

52119 (A/CONF.49/P-17) REVIEW OF NUCLEAR MEDICINE IN ISRAEL. **Lubin, Ernest (Beilinson Hospital, Israel. Dept. of Nuclear Medicine). Apr 1971. 9p. (CONF-710901-67). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

All seven major general hospitals in Israel today have well-equipped nuclear medicine departments with facilities for the diagnostic and therapeutic use of radioisotopes. Recently a decision was taken to provide all hospitals having more than 350 beds with the same facilities, and a radioisotope unit is now included in all new hospitals being planned. The clinical research being carried out in existing centers includes, among many others, a study of the microdosimetric, radiobiological and clinical aspects of ^{125}I, with the aim of attaining a better understanding of its potentialities as a therapeutic agent in cases of thyrotoxicosis. Furthermore, ^{113m}In-in vivo-labelled-transferrin is being used as a blood-pool marker to investigate the vascular bed of space-occupying-lesions in the liver, with the aim of improving the amount of diagnostic information provided by the liver scan. In this same direction, specific, labelled antibodies to amoeba are being used in animals in which amoebic abscesses have been experimentally induced in the liver. The development of nuclear medicine in Israel has triggered a parallel trend in the local planning and construction of suitable nuclear instrumentation as well as in the provision of reactor-produced radiopharmaceuticals. The problem now confronting nuclear medicine in this country is the shortage of well-trained medical personnel. With the inclusion of nuclear medicine in the curriculum of our medical school and post-graduate school of medicine, this should find its solution. (auth)

52120 (A/CONF.49/P-121) TWO APPLICATIONS OF RADIOISOTOPES IN MEDICINE: THE QUANTITATIVE RENAL EXAMINATION, AND THE RAPID CALCULATION OF THE DOSAGE IN RADIATION THERAPY. **Bischof-Delaloye, A.; Hedinger, W.; Delaloye, B. (Lausanne Univ. (Switzerland). Medical Clinic); Poretti, G. G.; (and others) (Bern Univ. (Switzerland)). Jun 1971. 8p. (CONF-710901-367). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Radioisotopic techniques, primarily those applied in medical diagnostics and therapy, have undergone such rapid development over the course of the past few years that methods which were still in the stage of pure research less than two years ago, have now become routine examinations. Two methods which have been modified to such an extent by the application of radioisotopes that investigations that were previously impossible have become truly scientific are cited as examples. These include quantitative renal examinations using ^{51}Cr-labeled EDTA-chromium scintigraphy to measure glomerular filtration rates and ^{131}I-labeled hippuran scintigraphy to measure plasma clearance rates, and the use of computers for the calculation of the radiation dose from γ sources used for interstitial radiotherapy of neoplasms. (C.H.)

52121 (A/CONF.49/P-125) PRODUCTION AND DISTRIBUTION OF RADIOPHARMACEUTICALS IN AUSTRALIA. **Boyd, R. E.; Engelbert, U.; Gregory, J. N. (Australian Atomic Energy Commission, Sydney). May 1971. 25p. (CONF-710901-164). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Since 1967, when the A. A. E. C. commenced the supply of radiopharmaceutical preparations, the annual value of shipments has risen from approximately $A5,000 to $A122,000. During this period of rapid development, attention has been concentrated on the production of short-lived radionuclides suitable for nuclear medicine, and the development of products of biological specificity by incorporating these radionuclides into suitable chemical compounds. New products are developed and evaluated by the Research Establishment in close cooperation with several nuclear medicine centers in Australia. The commission has developed a high temperature generator that yields large quantities of extremely pure ^{99m}Tc from relatively cheap, low specific activity irradiated molybdenum trioxide. This process provides pertechnetate solutions at concentrations of up to 30 Ci/ml which is ideal starting material for conversion to a variety of labeled compounds. The cooperative research with the medical centers has resulted in an improved technetium sulphide colloid and a ^{99m}Tc-labeled ferrous hydroxide suspension that give excellent results in liver and lung scanning respectively. These, together with brain and thyroid scanning agents are delivered daily to most of the major hospitals in the Commonwealth. Other products include preparations of ^{131}I, ^{18}F, ^{24}Na, ^{42}K, ^{32}P, and ^{169}Yb. Compact ^{99m}Tc chromatographic generators are produced, loaded with carrier-free ^{99}Mo extracted from irradiated uranium in a specially developed fission product separation plant where careful attention is paid to the removal of other fission product contaminants. This plant can also provide ^{133}Xe. In spite of the long lines of communication in Australia, short-lived radiopharmaceuticals are processed and distributed from a single national center, predominantly in a form ready for immediate parenteral use. This system permits uniform standards of manufacture and inspection and avoids duplication of highly specialised processing laboratories. Its main disadvantage is the loss of activity during long distance transport but a coordinated irradiation, processing, quality control, packaging, and rapid delivery service by road and air permits a nation-wide distribution of these radiopharmaceuticals; this service includes ^{18}F (half life 1.9 hr). The extensive use of this type of service is believed to be unique. Research work into new and improved radiopharmaceuticals is based upon and stimulated by the ever increasing activities of nuclear medicine centers in Australia. Current work is aimed at extending the diagnostic range of existing radionuclides. (auth)

52122 (A/CONF.49/P–161) MEDICAL APPLICATIONS OF RADIOISOTOPES AND RADIATION: TECHNIQUES AND USE IN DIAGNOSIS, THERAPY, AND RESEARCH. Abbatt, John D. (Department of National Health and Welfare, Ottawa (Ontario)); Batho, H. F. (British Columbia Univ., Vancouver); Cowper, D. R. (Atomic Energy of Canada Ltd., Ottawa (Ontario)); Rosenthall, L.; (and others) (Montreal General Hospital (Quebec)). May 1971. 13p. (CONF-710901–178). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In Canada an extensive base of clinical experience has been gained in the application of radioactive tracers in medicine, and some improved results have been developed. Significant progress in dynamic studies results from the use of inorganic radioactive materials, for example with thyroid and bone-function problems. Other valuable advances in medical uses of ionizing radiation have been made possible by the introduction of the gamma camera and radionuclides such as technetium-99^{m}; these lead to improved diagnosis by studies of spatial distribution of activity. However these approaches are somewhat empirical, and the next major step in diagnosis and possibly therapy must be based upon a basic mechanistic knowledge of physiology and biochemistry. This knowledge is only now becoming available, and the more physiological approach is exemplified by work at Montreal on respiratory physiology-disease. Using xenon-133 and a multidetector system, a technique has been perfected for quantitative studies of lung ventilation and perfusion. This method utilizes both chemical and radioactive properties of xenon. The TRIUMF accelerator at present under construction at the University of British Columbia will produce high-intensity beams of pi-mesons. A trial of pi-meson cancer therapy is planned, and the rationale of this clinical trial is based upon the main potential therapeutic advantages of this form of radiation that appear to be much improved depth-dose distribution over x- or gamma rays, electrons, or neutrons and a biological effectiveness less dependent on the state of tissue (tumor) oxygenation than in any other existing treatment regime. (auth)

52123 (A/CONF.49/P–203) NUCLEAR MEDICINE DEVELOPMENT PROGRAMMES IN BRAZIL. da Rocha, A. F. G.; Syllus, C. (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro). Jun 1971. 16p. (CONF-710901–369). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Programs of the Brazilian Nuclear Energy Commission for developing the use of radioisotopes in medical diagnosis are discussed. The main characteristics of the country, the available facilities, and the budget for 1967 are reviewed to show the situation before planning for the development of uses of radioisotopes in the field of medical application was begun. Since then the number of laboratories for nuclear medicine has increased. Programs for the participation of experts in different Brazilian scientific societies have been instigated and prototype laboratories in nuclear medicine have been established with the main purpose of increasing the training facilities for the use of radioisotopes in medicine. Preferential fields for research with radioisotopes were established. Owing to the local incidence of these diseases, a research program on tropical pathology, mainly schistosomiasis and Chagas disease, has been set up. A far reaching target, which consists of the construction of regional laboratories to make use of modern techniques and to allow medical research with radioactive tracers, has been set. The available budget for the program, the main results achieved, and the general situation of nuclear medicine in Brazil at the moment are reviewed. (auth)

52124 (A/CONF.49/P–263) MEDICAL APPLICATION OF THE RADIATION. Kakehi, K. (Chiba Univ. (Japan). School of Medicine); Umegaki, Y.; Tsunemoto, H. (National Inst. of Radiological Sciences, Chiba (Japan)). May 1971. 20p. (CONF-710901–99). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Progress made in the fields of nuclear medicine and radiotherapy in Japan is summarized. Scintigraphy is popular and around 400 scanners and 60 cameras are in operation for diagnosis at present. The organs examined most often are the thyroid gland, liver, brain, kidney, and pancreas. Radioisotopes were administered to 168,000 patients in 289 facilities during 1968. Research conducted emphasized improvement of the scintillation camera, data processing using computers, and the development of new radiopharmaceuticals, especially tumor localizing agents. About 60% of the licensed hospitals are standard radiotherapy centers and 32 linear accelerators and 30 betatrons have been installed in therapy centers. Therapeutic results obtained using high-energy and orthovoltage x radiation for the treatment of a number of neoplasms are reviewed. (auth)

52125 (A/CONF.49/P–324) CURRENT STATUS AND RESULTS OF NUCLEAR MEDICINE AND RADIOBIOLOGY IN HUNGARY. Varteresz, V.; Rode, I.; Petranyi, Gy. (National Research Inst. for Radiobiology and Radiohygiene, Budapest. National Inst. of Oncology, Budapest. Debrecen Univ. of Medicine, Hungary). May 1971. 10p. (CONF-710901–110). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In Hungary the medical application of radioisotopes started 15 years ago. A network, covering the whole country, and centering round universities and national institutes, developed in the past years. Iodine metabolism tests of the thyroids are performed in almost all laboratories. Circulation tests involving the heart, lungs, kidneys, liver, furthermore, cerebral and peripheral circulation are highly advanced. Haematological tests and hormone determinations are done in special institutes. Scanning is extensively used in the diagnostics of thyroids, lungs, liver, spleen and kidneys, etc. Therapeutic application is more limited. In internal medicine hyperthyroidism, cardiosclerosis and polycythaemia are conventional indications for radiation therapy. Tumor therapy is the most extensive application field. Sealed isotopes are applied in the therapy of gynaecological tumours and for curing the cancer of the skin, nose, nasal- and buccal cavities, pharynx and rectum. Teleirradiation high activity sources are represented exclusively by Co-units, with an average load (nominal) of 3,000 Ci, and used in the widest field of indications. Organized radiobiological researches have been performed for 18 years, with a central research institute functioning for 14 years. These investigations aim at elucidating the molecular, haematological, immunological and morphological action mechanism of radiations and at finding the means of influencing radiosensitivity. The radiosensitivity of certain mitotic phases is investigated. Important work is done to exploit biological radiation effect (radiosterilization, etc.). The biological experiments involve dosimetric and dose distribution investigations (phantom measurements). Exposure level to the population and its reduction possibilities are studied. The paper reports on the results achieved. (auth)

52126 (A/CONF.49/P–332) RADIOISOTOPE EXAMINATIONS OF BLOOD FLOW IN TISSUES AND ORGANS. Gembicki, M. (Medical School, Poznan, Poland); Graban, W. (Medical School, Warsaw). May 1971. 16p. (CONF-710901–112). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The use of radioisotopes in different hemodynamic studies concerned various tissues and organs. It depended on the technical possibilities. Modifications of different methods of hemodynamic investigations were adapted and prepared using as a tracer RIHSA as well as ^{133}Xe and Na^{131}I. It was also necessary to improve the method of determination of circulating blood

XUM

volume. Independently of clinical investigations, experimental studies on the problem of kidney transplantation and extracorporeal liver perfusion were performed. This program was conducted in cooperation with a group of surgeons working on an organ transplantation program. The results of the clinical and experimental work provided the basis for theoretical and modeling investigations on the parameters of blood flow through various tissues and organs. All these findings permitted a critical look at the methods used and the choice of the most accurate conditions for the clinical and experimental problems in hand. (auth)

52127 (A/CONF.49/P–407) ROLE OF RADIONUCLIDES IN THE DIAGNOSIS OF CANCER. Scheer, K. E.; Lorenz, W. J.; Schenck, P.; Lorenz, D. (Institute of Nuclear Medicine, Heidelberg (West Germany). Cancer Research Centre). Jul 1971. 28p. (CONF-710901–438). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The present status of the application of radioisotopes and labeled compounds for the diagnosis of neoplastic diseases is reviewed. Emphasis is put on the importance of early diagnosis and localization of tumors, which enables a considerable improvement in treatment results. Short-lived radioisotopes are of special importance for use in scintigraphy because they can be administered in higher doses and give more accurate results. Short-lived radioisotopes must be produced in the vicinity of the user by generators, reactors, or cyclotrons. This necessitates the in loco labeling of radiopharmaceuticals suitable for the localization of cancer. The advantage of using short-lived radionuclides for the early diagnosis and localization of cancer is demonstrated with ^{18}F. This radionuclide makes it possible to diagnose primary bone tumors and bone metastases considerably earlier than is possible by x-ray techniques. In several cases of known bone metastases it was possible to show, with the help of scintigraphic methods, that the dimensions of lesions were larger than anticipated from the roentgen picture, thus enabling a timely adjustment of radiotherapy to correspond to the size of the lesion. The choice of time between radioisotope administration and measurement is critical. This has to be determined for each individual radiopharmaceutical. The possibility of improving the results of scintigraphic examinations by the use of computers is demonstrated. This includes the correction for systematic errors in the radiation detector, the checking of statistical significance, and the effectiveness of inverse filters for improving the spatial resolution. (auth)

52128 (A/CONF.49/P–462) CLINICAL ASPECTS OF DIAGNOSTIC USES OF RADIOACTIVE ISOTOPES IN THE USSR. Agranat, V. Z.; Kalantarov, K. D.; Lyass, F. M.; Malov, G. A.; (and others) (Ministry of Health, USSR). Jun 1971. 34p. (CONF-710901–389). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Developments in radioisotope scanning in the USSR during the past 10 years are reviewed. The use of ^{125}I, ^{131}I, and ^{99m}Tc-pertechnetate for the diagnosis of the iodine exchange imbalance; the application of the radioisotopic methods for the clinical study of tumor growth and the assessment of the effectiveness of various types of anti-tumor therapy, as well as the study of the influence of the cancer on the vital organs function; the application of ^{133}Xe for evaluating the degree of cerebral circulation malfunction and localizing the level and degree of the spinal subarachnoid space blockage; and brain tumor localization during surgery by means of ^{32}P uptake are cited as examples. Developments in radiocardiography, together with radioisotope scanning, and whole-body counting using albumin compounds labeled with ^{131}I, have made it possible to detect the peculiarities of the hemodynamics in patients suffering from congenital heart disease, full lateral blockage, arterio-venous fistula, and thrombosis of the arterial and venous network vessels. The developed endobronchial radiometry, radiopneumography using ^{133}Xe, and radioisotope scanning with ^{131}I-MAA makes it possible not only to localize the pathologic process in the lungs but to study pathophysiologic mechanisms which are the basis of the peculiarities of the ventilation and blood flow regional functions associated with various lung pathology. In lung surgery clinics radioisotope methods permit the evaluation of functional operability and the functional compensation during the post-operation period. The methods of radioisotopic renometry and electroroentgenoscopy made it possible to make a quantitative assessment of the kidney parenchyma and precise localization of kidney lesions. (auth)

52129 (A/CONF.49/P–629) NUCLEAR APPLICATIONS IN THE BIOMEDICAL FIELD. Allemand, R.; Cordelle, M.; Delcroix, V.; Favier, C.; (and others) (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jul 1971. 5p. (CONF-710901–408). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In the field of nuclear medicine the developments in electronics have contributed to the progress of recent years, particularly with regard to the localisation, metabolism, and visualization of radionuclides inside the organism. The design of nuclear particle localisation detectors and associated electronic equipment has facilitated x- or γ-emitter visualization for the mapping or functional exploration of organs (scintigraphy). A stationary gas type detector (multidetector) has been developed that has a spatial resolution of 3 mm and is particularly suited to thyroid studies using ^{125}I. In addition, a complete apparatus for the functional exploration of the lungs, equipped with a large multidetector, is at present being designed. Measurements of the cerebral blood flow following intra-carotid injection or inhalation of ^{133}Xe, and the use of x-ray fluorescence of stable xenon to carry out local blood flow measurements, particularly on the lower limbs, are under investigation. (auth)

52130 (A/CONF.49/P–631) CONTRIBUTION TO THE DEVELOPMENT OF NEW RENAL, PANCREATIC, THYROID, AND CARDIAC RADIOISOTOPIC EXPLORATION TECHNIQUES. Kellershohn, C.; Raynaud, C.; Ricard, S.; Royer, P.; (and others) (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1971. 30p. (CONF-710901–457). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The amount of ^{197}Hg and ^{203}Hg fixed by the kidneys has been measured in 1,000 patients since 1961. The measurement performed by quantitative scintigraphy is simple, accurate, harmless and well tolerated by the patient. In normal subjects over four years old its value is 27 ± 3.5% for the right kidney and 26 ± 3.5% for the left. In cases of unilateral kidney disorder the sum of the two fixations is normal, the healthy kidney compensating the deficiency in the diseased one. This examination is recommended in high blood pressures of renal origin, in blockages of the urinary tract, to study the efficiency of medical or surgical therapy, and to study compensatory function. The method of subtracting the image of the liver alone obtained with colloidal ^{198}Au from the combined scintigraphic image of the liver and pancreas obtained with ^{75}Se-selenomethionine is a well-established means of obtaining a faithful image of the pancreas. A method is presented by which those two images may be visualised simultaneously using a 16,000 channel analyser, and the result of their subtraction obtained by direct display of a subtraction coefficient between 0.001 and 9.99. The application of the method to the study and treatment of pancreas ailments is discussed. The images of ^{125}I-labeled thyroid glands obtained by conventional scintigraphy and by the use of a spark chamber were compared in 300 subjects. They confirmed the theoretical superiority of the spark chamber due to its very fine 1.5 mm geometrical resolution. Small or thin regions such as the Lalouette pyramid or the isthmus can then be revealed, but above all the stationary detector better circumscribes the boundaries of a hot or cold nodule and distinguishes small zones of hypofixation difficult to discern or invisible when using conventional scintigraphy. A method of measuring coronary flow, based on the comparison of radiocardiograms obtained with a myocardium fixed tracer, ^{86}Rb, and a non-diffusible tracer, ^{99m}Tc-labeled red blood corpuscles, is described. Its validity was checked by comparison with direct measurements carried out during coronary bridging operations. The value of the method in cardiological medicine is discussed. (auth)

52131 (A/CONF.49/P–639) EXPERIENCES IN A RADIOISOTOPE AND RADIOTHERAPY CENTRE IN A DEVELOPING COUNTRY. Sheikh Abdel Rahman, El; Hidayatalla, Abdalla; Abdel Rahman, Ibrahim. May 1971. 12p. (CONF-710901–304). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Khartoum Radiation and Isotope Center is one of the early centers of its type to be started in a developing country. The center, which started functioning early in 1967, deals with current applications of radioisotopes and ionizing radiations for both diagnostic and theraputic purposes. Its functions include the use of x rays and radiations from sealed and unsealed radioactive isotopes for the treatment of malignant and non-malignant conditions. It also includes an active laboratory for studies on uses of radioisotopes for medical diagnosis and research purposes. The center works in close association with the Faculty of Medicine and Khartoum General Hospital and is serving the whole country, especially in the treatment of cancer. The Sudan, with

fifteen millions population and one million square miles, encompasses all the problems and difficulties of development in other African countries. The experience gained in Sudan in relation to the Radioisotope Center would no doubt be of immense usefullness to other African countries of a similar stage of development, particularly those embarking on a similar program for the use of radioisotope in medicine. (auth)

52132 (A/CONF.49/P–653) USE OF RADIOISOTOPES AND RADIATION IN MEDICAL AND ALLIED FIELDS AND THEIR PUBLIC HEALTH IMPLICATIONS. Windeyer, Brian. May 1971. 13p. (CONF-710901–309). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The use of radiation in medicine has been developing in importance. Diagnostic radiology using x rays has become the most important single diagnostic method in clinical medicine and the development of new techniques is increasing its importance. Radiotherapy using x rays and the radiations from naturally radioactive substances such as radium has become of first importance in the treatment of cancer in all its stages, as a curative and as a palliative method. The advent of radioisotopes has been of fundamental importance in medicine and allied fields. In radiotherapy, sealed sources have provided new and efficient types of apparatus, some of which are replacing radium entirely. There has been some use of unsealed sources, particularly radioactive isotopes of iodine for thyrotoxicosis but, apart from these, in general unsealed sources administered by injection or by mouth have not made a great therapeutic impact. It is, however, in the field of diagnosis and of investigation and research that unsealed sources have provided completely new methods of the greatest value which are being expanded and exploited with rapidity. Some in vitro tests have provided diagnostic evidence which could not be obtained by other methods. Others give more accurate and reliable information with greater speed and simplicity than former assay techniques. The range of investigation is wide and increasing. Topographical studies of organs and tissues with radioisotopes are important methods of investigation. They give vital evidence, sometimes alone and sometimes confirmatory of methods of diagnostic radiology. They have provided the necessary evidence with much reduction of radiation exposure. In some instances the evidence from radioisotope scanning can be obtained long before it can by any other method. Functional studies of organs such as kidney and liver have also become routine procedures. They are facilitated by advances in instrumentation which now demonstrate dynamic as well as static concentrations of the nuclide. New, short-lived isotopes are being produced which considerably reduce the dose of radiation and there is great activity in the development of labelled pharmaceutical substances which can demonstrate an increasing range of metabolic phenomena. In addition to these diagnostic advances, the whole range of radioisotopes, with the development of sophisticated techniques, has given new tools of the utmost precision and delicacy for research into cellular and sub-cellular mechanisms. They have great importance for the health of populations, providing earlier and more accurate diagnosis and have greatly added to the sum of knowledge in medicine and biology generally. (auth)

52133 (A/CONF.49/P–739) RADIOISOTOPIC INVESTIGATIONS IN SOME TROPICAL DISEASES. Ganatra, R. D.; Sharma, S. M.; Da Costa, H.; Samuel, A. M.; (and others) (Bhabha Atomic Research Centre, Bombay (India)). May 1971. 29p. (CONF-710901–326). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The contribution of radioisotopes as additional diagnostic and therapeutic tools in the hands of clinicians is well known. In underdeveloped tropical countries radioisotope tracer techniques have proved to be of immense help for quicker diagnosis and effective treatment of maladies commonly prevalent in the tropics. Liver scans were done on more than 950 patients during the last seven years for the diagnosis of a variety of liver diseases, including amoebic abscesses, cirrhosis, primary and secondary liver malignancies, and hydatid cysts. Colloids of the short lived ^{113m}In is used at present for liver scintigraphy. The usefulness of liver scanning in the diagnosis and assessment of therapeutic response in liver abscesses and cirrhosis is discussed. Radioisotope techniques have also proven of value for studies on the etiology of anemias, for studies of albumin metabolism in patients with tropical sprue, and for studies on patients with symptoms of nutritional and vitamin deficiencies. (auth)

52134 ^{133}Xe RADIOSPIROMETRY WITH MOVING DETECTORS. NORMAL VALUES AND REPEATABILITY. Korhonen, O. (University Central Hospital, Helsinki). Scand. J. Clin. Lab. Invest.; 27: No. 2, 113-21(Apr 1971).

Percentile regional distributions of pulmonary blood flow, ventilation, vital capacity, and total lung capacity in supine position were studied in 55 healthy subjects with ^{133}Xe radiospirometry, by using two pairs of moving detectors. Normal values and repeatability of this method were found to be comparable to those obtained with other methods. The influence of the subject's position with reference to the detectors was also evaluated. (auth)

52135 BETA RADIOPHARMACEUTICAL IDENTIFICATION BY QUENCH ANALYSIS. Ice, Rodney D. (Univ. of Michigan, Ann Arbor); Dugan, Mary Ann. J. Nucl. Med.; 12: No. 8, 552-4(Aug 1971).

The identification of an unknown beta-emitting radiopharmaceutical requires the counting of the sample with added amounts of chloroform, establishing the degree of quench associated with the chloroform, calculating the slope when plotted against a ^{45}Ca standard, and locating the slope on the calibration curve. The radiopharmaceutical is identified by the maximum beta energy associated with the slope. Radiopharmaceuticals labeled with ^{14}C and ^{35}S, with very similar maximum beta energies, 0.158 and 0.167 MeV, respectively, cannot be separately identified by this technique. The standard deviation for the two similar beta energies overlap. This technique can be expanded to higher energy emitters by using a different quenching agent and a different reference standard. Use of other reference standards would require a different standard beta identification curve. A method was developed for the identification of beta-emitting radiopharmaceuticals without chemical separation or use of absorbers. Use of the method outlined and the standard curve presented allows radionuclidic identification, as well as simultaneous assay of a beta-emitting radiopharmaceuticals. (auth)

52136 BEAM QUALITY MEASUREMENTS IN DIAGNOSTIC ROENTGENOLOGY. Trout, E. Dale; Kelley, John P. (Oregon State Univ., Corvallis). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 3, 622-7(Jul 1971).

This study indicates that the twentieth-value layer in aluminum is a meaningful and useful beam quality specification which, when applied with correction for exposure rate, can be used to predict the roentgenographic exposure required for a single-phase, three-phase, twelve-pulse, and equipment operating at higher frequencies. It is recommended that, in the diagnostic area, the half-value layer be retained for determination of beam filtration only. When specification of beam quality is to be used in predicting roentgenographic exposure, it is recommended that the twentieth-value layer be used, applying the necessary correction for exposure rate. (auth)

52137 SPLENOSIS DEMONSTRATED BY SPLENIC SCAN. Jacobson, Sally J.; De Nardo, Gerald L. (Univ. of California, Davis). J. Nucl. Med.; 12: No. 8, 570-2(Aug 1971).

Splenosis is the autotransplantation of splenic tissue following spleen trauma. It may result in vague symptoms and abdominal masses and must be considered when abdominal trauma has occurred in the past. The splenic scan is a suitable method for the preoperative diagnosis of splenosis because radioactive colloidal particles or damaged erythrocytes are localized in all functioning splenic tissue. Prior to the advent of the splenic scan, the diagnosis of splenosis was established by laparotomy. (auth)

52138 ^{157}Dy-HEDTA FOR SKELETAL IMAGING. Subramanian, G. (Upstate Medical Center, Syracuse, N. Y.); McAfee, J. G.; Blair, R. J.; (and others). J. Nucl. Med.; 12: No. 8, 558-61(Aug 1971).

Dysprosium-157 appears to be the best rare-earth nuclide available for skeletal imaging using either rectilinear scanner or scintillation camera. It is readily produced in a cyclotron from natural terbium, but the p,3n reaction requires protons of 33 MeV. Its monoenergetic gamma emission of 326 keV, with an external photon yield of 91%, is more suitable for use with the Anger camera than the higher energy photons of ^{18}F or ^{85}Sr. Its half-life (8.1 hr) is 4.4 times greater than ^{18}F, so that shipping problems are not as great. Imaging studies may be performed 4 to 6 hr, or 18 to 24 hr after administration. The skeletal localization of the HEDTA chelate is similar to other heavier lanthanons studied previously. Fortunately, there is no gastrointestinal excretion to obscure the abdominal or pelvic bones, as occurs with nuclides of strontium or barium. Fracture sites in experimental animals were well demonstrated by imaging, so that it is likely that other lesions, including skeletal metastases, can be detected also. (auth)

52139 INFLUENCE OF PREVIOUS LUMBAR PUNCTURE AND PNEUMOENCEPHALOGRAPHY ON THE INCIDENCE OF UNSUCCESSFUL RADIOISOTOPE CISTERNOGRAPHY. Larson, Steven M.; Schall, Gerald L.; Di Chiro, Giovanni (National Institutes of Health, Bethesda, Md.). J. Nucl. Med.; 12: No. 8, 555-7(Aug 1971).

Radioisotope cisternography is universally accepted as a valuable aid in the differential diagnosis of abnormalities of cerebrospinal fluid (CSF) dynamics. With widespread application of the technique has come the recognition of the frequent occurrence of inadequate injections. Reported incidences have ranged from 11 to 24% of attempted cisternograms. The scintiphotos of the lumbar spine after an unsuccessful study support the concept of CSF leakage at the time of the injection. For example, in the classic subdural injection, the volume of distribution of the tracer in the subdural space, normally containing no fluid, is much greater than the volume of the injectate (0.5 ml). It is concluded that events at the actual time of the attempted cisternogram, rather than the history of previous procedures, probably determine whether a study will be ultimately successful. (auth)

52140 PROBLEMS IN DIAGNOSIS OF BONE METASTASES OF MAMMARY CANCER. CONTRIBUTION OF WHOLE-BODY SCANNING WITH ^{85}Sr. Monetti, N.; Napoli, D.; Turba, E.; Bellanova, B. (Istituto di Radiologia e Terapia Fisica, Bologna). Radiobiol. Radioter. Fis. Med.; 24: No. 6, 386-404(Nov-Dec 1969). (In Italian).

The photoscanning with ^{85}Sr, executed by whole-body scanning, was utilized in the systematic study of skeletal metastases originating from mammary cancer. This methodology was employed in 46 cases, most of them already treated with mastectomy. Patients complaining of bony pains (25 cases) were selected and others who did not present any painful symptomatology (21 cases). The whole-body scanning proved to be very useful: it permits confirmation of radiographic, tomographic, and segmentary photoscanning ascertainments in the sites where an anomalous accumulation of radioactive isotope can be found. It is possible in this way to recognize metastatic bony lesions in the initial stage or any way asymptomatic and to express therefore the most accurate and complete diagnostic response, which is a necessary premise to an exact outline of the therapeutic plan. (auth)

52141 SCINTIGRAPHIC INVESTIGATION OF THE UPTAKE OF RADIOACTIVE MERCURY IN LUNG TUMOURS. Pokorna, I.; Klvana, M.; Klimo, J. (Safarik Univ. School of Medicine, Kosice, Czech.). Neoplasma; 18: No. 3, 317-23(1971).

Color-scanning of bronchial carcinomas with radioactive mercurichloride (^{197}HgCl$_2$), as well as its clinical value are described. The method is reliable to a high degree (93% in the present series) and makes it possible to verify the malignant nature of pulmonary lesions, even in cases where other methods of investigation fail. Color-scanning with radioactive mercury enables the determination of the actual size of neoplastic infiltration in many cases with greater accuracy than radiography. This may be an important help in defining the optimal field-size in radiation therapy, as well as in pre-treatment staging of bronchial carcinomas. (auth)

52142 SCANNING WHOLE-BODY COUNTER FOR CATTLE. Sansom, B. F.; Taylor, P. J.; Wheelock, D.; Vagg, M. J. (Institute for Research on Animal Diseases, Compton, Eng.). pp 125-33 of Mineral Studies with Isotopes in Domestic Animals. Vienna; International Atomic Energy Agency (1971).

From Panel on mineral studies with isotopes in domestic animals; Vienna, Austria (28 Sep 1970). See STI/PUB-293; CONF-700966.

The design of the Compton whole-body counter for cattle consists of three parts: (I) a low-background cave in which the major shielding material is chalk; (II) a detector system consisting of three large plastic scintillation counters arranged symmetrically in a vertical plane around the animal and able to scan along its length at different rates; and (III) an electronic system which can measure both the total radioactivity and its distribution within the animal. Preliminary results are reported showing that less than 0.5% dietary manganese is absorbed from the gastro-intestinal tract of cows. The value of the instrument for measuring radioactivity in samples weighing up to 50 kg is also discussed. (auth)

52143 POSITION OF ^{87}Sr IN SKELETON SCINTIGRAPHY. COMPARATIVE INVESTIGATIONS WITH ^{85}Sr. Sauer, R. (Buergerspital, Basel). Schweiz. Med. Wochensch.; 101: No. 31, 1129-37(7 Aug 1971). (In German).

Comparative studies were performed in 70 patients using ^{87m}Sr and ^{85}Sr. The patients were divided into three groups according to the main indications for scintigraphy of bone lesions: detection of metastatic cancer to bone, osteonecrosis, or bone involvement in various kinds of arthritis. The increased uptake of ^{87m}Sr in benign or malignant bone disease is—as opposed to ^{85}Sr deposition—due to hyperemia of the affected bones and only secondarily to changes in bone metabolism itself. In using ^{87m}Sr, the extent of true bone metabolism can be determined. In cases of extraosseous disorders, for example arthritis, it is impossible to determine bone involvement. For detection of bone metastases ^{85}Sr should be given preference over ^{87m}Sr. An exception can be made when frequent repetition of the scan is desired in order to evaluate response to therapy, and for the examination of seriously ill patients, in which the duration of the procedure can be shortened using ^{87m}Sr. In these cases scintigraphy by means of ^{87m}Sr provides information of sufficient reliability. Strontium-87m is not suitable for the assessment of bone repair after fractures. Otherwise, ^{87m}Sr should prove of particular value in evaluating nonmalignant bone disorders because of its small radiation dose to bone, especially in the examination of growing bone. (auth)

52144 COMPUTER ASSISTED CEREBRAL BLOOD FLOW STUDIES. O'Reilly, R. J.; Ronai, P. M.; Cooper, R. M.; Marion, M. A. (Inst. of Medical and Veterinary Science, Adelaide). Australas. Bull. Med. Phys. Biophys.; No. 50, 13-20(1 Aug 1971).

Digital analysis of cerebral radionuclide blood flow studies using a gamma scintillation camera and utilizing a CDC 6400 computer for analysis of recorded tapes is described. Cerebral blood flow curves were obtained by the computer which sums the counts obtained in each of two selected regions of interest for each 2 sec exposure. Good correlation between flow curves and log pictures and clinical presentations was obtained following modifications to the head alignment device, corrections for variation in the gamma camera crystal sensitivity, and computer selection of regions of interest. (Australia)

52145 MEDIASTINUM SCANNING WITH ^{75}Se-SELENOMETHIONINE. Goel, Yogendra; Sims, James; Pittman, James A. (Univ. of Alabama, Birmingham). J. Nucl. Med.; 12: No. 9, 644-5(Sep 1971).

Selenium-75-selenomethionine scanning is a simple, safe, and atraumatic procedure for visualizing mediastinal masses, as compared with other investigative procedures such as pneumomediastinography and venography. This radiopharmaceutical is incorporated into actively dividing cells of various neoplasms, including bronchogenic carcinoma, and apparently into noninvoluted thymus tissue. A dose of 250 μCi has been estimated to deliver 2.2 rads to the whole body, 2.5 rads to the gonads, 14 rads to the kidneys, 0.6 rads to the pancreas, and 0.5 rads to the liver (6). This radiation dose is within acceptable limits for diagnostic studies in such patients. Mediastinal scanning provided information confirmatory of a mass in one of our patients and in the other allowed detection of a mediastinal mass that was not otherwise clearly apparent. The ^{75}Se 265-keV photopeak was sufficient to penetrate the thorax, and the target-to-background ratio of radioactivity in these studies was sufficient for the lesion to be seen on scans in the above conditions. Selenomethionine scanning should prove useful for routinely delineating occult thymomas and other mediastinal masses. (auth)

52146 UPTAKE OF ^{203}Hg-HYDROXY-MERCURY-FLUORESCEIN IN MYOCARDIAL INFARCTS. Ramanathan, P.; Ganatra, R. D.; Daulatram, K.; Sen, P. K.; Blau, M. (Bhabha Atomic Research Centre, Bombay. KEM Hospital, Bombay). J. Nucl. Med.; 12: No. 9, 641-3(Sep 1971).

Distribution of ^{203}Hg-labeled hydroxy-mercury-fluorescein was studied in a series of 22 dogs in whom a myocardial infarct was produced by ligation of a branch of the coronary artery. Several procedural variations were tried, but they did not seem to alter the results significantly. The ratio of radioactivities in ischemic myocardium to normal myocardium varied from 5.89 to 1.04. The liver showed a maximum of 29.8% of the administered dose 4 hr after injection, while the kidney showed a maximum of 34.2% at the same period. The results did not appear to indicate that this agent in its present form would be effective for in vivo scanning of myocardial infarcts. (auth)

Radiotherapy

Refer also to abstracts 51726, 51728, 51729, 51916, 51917, 52074–52076, 52078–52080, 52174, 52232, 52233, 52237–52241, 52245, 52246, 52249, 52251, and 52489.

52147 (A/CONF.49/P-437) MAIN TENDENCIES AND PROSPECTS FOR DEVELOPMENT OF RADIATION THERAPY IN THE USSR. Pavlov, A. S.; Baisogolov, G. D.; Kostromina, K. N.; Khrushchov, M. M. (Ministerstvo Zdravookhraneniya SSSR, Moscow). Jun 1971. 16p. (In Russian). (CONF-710901-487). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Progress in the field of experimental and clinical oncology, radiobiology, and nuclear physics has promoted radiation therapy as one of the leading methods for treating malignant tumors. The general principles of radiation treatment are based on the existence of local phases of development of the tumor process, which makes it possible to consider directed irradiation as a factor in presenting conditions for the radical treatment of an oncological patient. The main points in modern radiation therapy are a clear verification of the disease diagnosis and the obtaining of objective information on the localization and limits of the anatomical spread of the tumor process. In this connection, one of the tendencies in the development of radiation therapy in the USSR finds its expression in improving methods of topical diagnostics and establishing principles for the individual planning of the radiation treatment with reference to the tasks of the clinic. One of the most important ways for optimum realization of the therapeutical treatment, along with clinical data, are investigations aimed at the elucidation of various radiobiological mechanisms. That is why at the present time studying biological laws of tumor development, radiation regression, and the kinetics of reconstruction processes in the tumor and the normal tissues, predetermines a scientifically based approach to evaluating the absorbed dose of radiation and its distribution in time and in an irradiated volume of tissue. Efforts aimed at stimulating the radiosensitivity of the tumor and using the effects of tumor sensitization and radiation effect potentiation, also stimulate the further progress of radiation therapy in the USSR. Of significant importance, is the development of radiation physical parameters for radiation therapy and its optimization by applying computer techniques; also important is the increasing of precision by automation of the processes of radiation therapy. The development of radiation therapy also requires the solid and comprehensive training of specialists in this field and continuous improvement of the organization of radiological service. (auth)

52148 (A/CONF.49/P–508) FAST NEUTRON BEAMS FOR RADIOTHERAPY. Bewley, D. K. (Medical Research Council, London (England). Cyclotron Unit); Fowler, J. F. (Hammersmith Hospital, London (England). Postgraduate Medical School). May 1971. 12p. (CONF-710901–226). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A major therapeutic advantage of densely ionizing radiation is that cells in malignant tumors which are poorly supplied with oxygen are more readily killed than by lightly ionizing radiation such as x rays or gamma rays from cobalt-60. Thus tumors can be treated more effectively while normal tissues receive no more injury than from conventional types of radiation. The current status of the use of neutron beams (or negative π mesons) for therapy is discussed. Problems encountered are attributed to the wide spectrum of ionizing density in the beam, and the fact that some tumors re-oxygenate during x ray treatment and hence do not need the neutron beam. Progress in the project at Hammersmith Hospital, London using the Medical Research Council cyclotron neutron beam is described. (auth)

52149 (A/CONF.49/P–642) EXTRA-CORPOREAL IRRADIATION OF BLOOD FOR IMMUNO-SUPPRESSIVE THERAPY, EQUIPMENT, DOSIMETRY, AND MEDICAL EXPERIENCE. Weeke, E.; Rasmussen, I.; Christensen, P.; Boetter-Jensen, L. (Danish Atomic Energy Commission, Risoe. Research Establishment). May 1971. 10p. (CONF-710901–306). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Extracorporeal irradiation of blood (ECIB) has been used for immunosuppressive treatment prior to renal transplantation at the University Hospital, Copenhagen, since 1968. The irradiator development, dosimetry techniques, and medical experience are reported. Based upon early experience using a heavy, stationary irradiator, a mobile gamma therapy unit with integral shielding was developed. Main design features are two independently operated irradiation channels, each yielding a continuously variable transit dose between 0 and 750 rads at a blood flow of 100 ml/min. Two units are at present in operation at the hospital. Portable beta-irradiators of prototype design, incorporating ^{90}Sr–^{90}Y sources, were introduced in clinical research early in 1971. All irradiators were calibrated by thermo-luminescence dosimetry techniques. Transit dose measurements are performed using lithium borate suspended in demineralized water and passed through the extracorporeal shunt. The influence upon absorbed dose from particle size and fluid viscosity were investigated. The dose rate distribution along the irradiation channels were measured, and comparison between the results from transit dose and dose rate measurements showed fair agreement. The method has shown a high degree of reliability in the calibration of irradiation systems for fluid media, owing to a simple and manageable measurement set-up and a good reproducibility. A total of 70 patients had received ECIB prior to kidney transplantation up to December 1970. A pronounced and prolonged reduction of the lymphocyte concentration in the peripheral blood was achieved in all patients. The immunological function of the lymphocytes after ECIB-treatment was studied by means of lymphocyte transformation tests, and showed a certain deterioration in some cases. The frequency and severity of graft rejection episodes were compared between an ECID-treated group of 16 patients and a reference group of 29 patients. A significant reduction in rejection episodes within the first 6 weeks and a higher frequency of graft survival within the first 6 months were demonstrated in the former group. Based upon the present clinical results, it is concluded that the ECID-treatment is an effective means for immunosuppressive therapy for kidney transplantation. (auth)

52150 (A/CONF.49/P–654) TWO YEARS EXPERIENCE IN THE USE OF ^{125}I FOR TREATMENT OF THYROTOXICOSIS. Lewitus, Z.; Lubin, E.; Rechnic, J.; Rosenberg, T.; (and others) (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Apr 1971. 16p. (CONF-710901–654). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The radiobiological pecularities of ^{125}I suggest that this isotope could be a suitable substitute for ^{131}I in the treatment of hyperthyroidism. Reevaluation of the dosimetry from ^{125}I at the cellular level in the thyroid of mammals explains the differences in the biological effects of ^{125}I as compared to ^{131}I. Based on these theoretical considerations, ^{125}I was introduced in the treatment of patients with hyperthyroidism. Results are reported on 70 such patients treated with different doses of ^{125}I and followed for a period of from six months to two years. It was found out that although very small doses of ^{125}I (in the range of 1 to 3 mCi) caused remission more than 60% of the patients suffered relapse. Furthermore, even this small dose was found to produce a transient hypothyroidism in a few patients. Doses in the range of 6 to 8 mCi of ^{125}I did not show any particular advantage over similar doses of ^{131}I, except for earlier response. A combined dose of 2.5 mCi of ^{125}I plus 2.5 mCi ^{131}I (on the average) gave excellent results. A response was noted four to six weeks after the treatment and no signs of hypothyroidism have been observed. The whole-body burden from this combined dosage (calculated in rads) was found to be about half the amount expected from a similar dose of ^{131}I alone. (auth)

52151 (A/CONF.49/P–752) USE OF PROTON BEAMS IN USSR FOR MEDICAL AND BIOLOGICAL PURPOSES. Blokhin, N. N.; Goldin, L. L.; Dzhelepov, V. P.; Ruderman, A. I.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). State Atomic Energy Committee, USSR. Academy of Medical Sciences, USSR). Jun 1971. 21p. (CONF-710901–424). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The proton beams of the JINR cyclotron and of the ITEP proton synchrotron have been used for medical and biological purposes during the past several years. At the JINR cyclotron the proton beam with the energy of 670 MeV is slowed down in the polyethylene filter and by means of an evacuated focusing ion guide transported into the procedure room, equipped with dosimetry and patient-fixing set-ups. The intensity is 8.10^{11} protons/sec^{-1} at the exit of the accelerator, and 9.10^{8} protons/sec^{-1} in the procedure room. Maximum density of the beam is equal to 5.10^{7} cm^{-2} sec^{-1}. Medical treatment was applied to 21 patients. At the ITEP proton synchrotron the beam is released from the vacuum chamber of the accelerator at the time when the proton acquire the energy needed for the patient in question. This energy may be varied from 70 to 200 MeV. The magnetic cycles at the accelerator alternate. After each cycle used for elementary particle physics (7 GeV), there follows a short cycle generating the medical beam. Such a mode of operation allows the use of the beam for biological investigations and clinical irradiation during all the time the accelerator works. The beam density is 1.10^{9} cm^{-2} sec^{-1}. The medical treatment was applied to 70 patients. The dosimetry investigations and the clinical results obtained at both accelerators confirm the high quality of the dose fields and good therapeutic characteristics of the proton beams. (auth)

52152 (UCRL–20836) UNCONVENTIONAL RADIATIONS IN RADIOTHERAPY. Raju, M. R. (California Univ., Berkeley). Jun 1971. Contract W-7405-eng-48. 10p. (CONF-700645–2). Dep. NTIS.

XUM

From Conference on newer techniques and technology in radiotherapy and oncology; Los Angeles, Calif. (5 Jun 1970).

Data on the depth-dose distribution of high-energy x radiation, ^{60}Co γ radiation, high-energy electrons, proton beams, neutron beams, charged helium ions, and negative π^- mesons are reviewed. It is pointed out that significant improvements in the cure rate of neoplasms and in reducing complications following radiotherapy have resulted from the use of high-energy x rays and electrons. Further improvements expected following the use of heavy charged particles are discussed. Irradiation facilities using protons, neutrons, and charged helium ions for therapy are listed and the therapeutic results obtained are briefly reviewed. The biological basis for the improvements in radiotherapy expected from the use of negative π mesons is discussed. (C.H.)

52153 ENDOLYMPHATIC THERAPY USING ^{131}I-LABELED LIPIODOL. Hennig, K.; Franke, W.-G.; Platzbecker, H.; Herzmann, H.; Boelke, L. Radiobiol.-Radiother.; 11: No. 3, 277-87 (1970). (In German).

Experiences with endolymphatic therapy of lymphatic neoplasms are reported which were preponderantly performed using ^{131}I-lipiodol. The early results are encouraging. (auth)

52154 REDUCTION OF INTESTINAL REACTIONS BY TRENDELENBURG'S POSITION DURING PERCUTANEOUS IRRADIATION OF MALIGNANT TUMORS OF THE ORGANS OF THE SMALL PELVIS. Michailov, V. Radiobiol.-Radiother.; 11: No. 3, 305-8(1970). (In German).

In order to reduce intestinal reactions during radiation therapy of malignant tumors in the pelvic organs, a method is suggested in which the position of the patient is changed in such a way that as few loops of the intestine as possible remain within the beam. A position is described that proved most suitable, in which the patient remains for a short while only, owing to the high energy-level of modern x radiation sources. (auth)

52155 CHANGES OF THE WHITE BLOOD-PICTURE DURING THE COMBINED APPLICATION OF X-IRRADIATION AND CYCLOPHOSPHAMIDE. Glaser, F. H.; Glaser, L. (Martin-Luther-Univ., Halle, Ger.). Radiobiol.-Radiother.; 11: No. 4, 441-8(1970). (In German).

Leukocyte levels were examined in 139 patients who were treated for different neoplastic diseases by cyclophosphamide in continuous small doses; 43 patients were exclusively chemotherapeutically treated and 96 were additionally x irradiated. The depressant effect on the leukocytes of chemotherapy only and of combined therapy was studied. Whereas leukopenias occurred in more than a quarter of the patients with cyclophosphamide only, leukopenic reactions were found in more than a third in the group with combined treatment. The rate of leukopenia and the relative decrease of leukocytes were significantly influenced by the height of the starting level. An especially high decrease of leukocytes was found at periods of high radiation doses in the area of the trunk. The reversibility of the observed leukopenic reactions was good and severe complications did not occur even during combined therapy. (auth)

52156 DOSE DISTRIBUTION IN THE KIDNEYS AND URINARY TRACT IN PATIENTS WITH TESTICULAR TUMORS AFTER CONVENTIONAL AND TELECOBALT IRRADIATION. Tietze, D.; Prager, W.; Taubert, W. (Karl-Marx-Univ., Leipzig). Radiobiol.-Radiother.; 11: No. 5, 597-600(1970). (In German).

Techniques used for post-surgical irradiation of patients with testicular tumors using conventional x radiation and telecobalt γ radiation are described. Measurements were made of the radiation dose absorbed by the kidneys and urinary tract using both techniques. Pendulum irradiation techniques using wedge filters reduced the radiation dose to the kidneys and urinary tract during therapy. (auth)

52157 RESULTS OF RADIATION THERAPY WITH HIGH SINGLE DOSES FOR ESOPHAGEAL CARCINOMA. Balmuchanov, S. B.; Zolkiver, K. I.; Smagulov, A. S.; (and others) (All-Union Research Inst. for Oncology and Radiology, Alma-Ata, USSR). Radiobiol.-Radiother.: 11: No. 3, 225-34(1970). (In German).

The results of x radiation therapy of very advanced types of esophageal carcinoma were compared in two groups of patients. The patients of the first group were treated by the method of high single doses (single tumor dose of 600 to 800 rad in an interval of three to four days, total dose of 3500 to 4500 rad). Those of the second group were treated by means of the routine method of daily irradiation (single dose of 150 to 200 rad, total dose of 600 to 8000 rad). The immediate results of the treatment were better in the first group (partial or complete disappearance of the tumor in 91 out of 100 patients) than in the second (78 out of 113 patients). The general and local complications induced by radiation were nearly the same in both groups. Up to one year following treatment a statistically significant difference was found between the survival curves of both groups in favor of the first group, however, this difference disappeared. The mean duration of life of the patients of the first group was 10.3 ± 1.3 months and that of the second group was 6.4 ± 0.9 months. The teleirradiation performed using modern megavoltage irradiation units and high single doses yielded better palliative results compared with daily low single doses. (auth)

52158 FUNDAMENTAL AND PRACTICAL ASPECTS OF THE APPLICATION OF FAST NEUTRONS IN CLINICAL RADIOTHERAPY. Meeting held at Rijswijk, Netherlands, June 22-24, 1970. Eur. J. Cancer; 7: No. 2-3, 97-267(May 1971). (CONF-700655).

Nineteen papers linked by general discussions were presented on the following subjects: (1) various neutron sources, collimation, neutron dosimetry, and the characteristics of tritium targets; (2) various aspects of tumor and normal tissue radiobiology, including the oxygen enhancement ratio (OER) and the dependence of the relative biological effectiveness (RBE) on dose and dose fractionation; (3) factors determining the response of tumors to ionizing radiation and the selection of tumor types for clinical trials. Separate abstracts were prepared for each paper. (UK)

For abstracts of individual papers see: 52078–52080, 52109, 52159–52167, 52198–52201, 53496, and 53497.

52159 OXYGEN EFFECT AND RADIOTHERAPY WITH FAST NEUTRONS. Thomlinson, R. H. (Hammersmith Hospital, London). Eur. J. Cancer; 7: No. 2-3, 139-44(May 1971).

From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

The effect of hypoxia on the neutron-sensitivity of tumor cells is considered in relation to the development of hypoxia before therapy is begun; the size of each dose; reoxygenation between doses; and the oxygen enhancement ratio at the time the last dose is given. The consequence of some of these changes is illustrated by the experimental fibrosarcoma RIB$_5$, which contains 17% hypoxic cells before irradiation. This population rose immediately after a dose of radiation to an extent dependent on the dose, fell within 18 hr of a large dose, rose again to a second peak at 48 hr, then fell again. The RBE consequently varied with time after irradiation. The mechanism of these changes is discussed. (auth)

52160 THERAPEUTIC MARGINS IN CLINICAL RADIOTHERAPY WITH CONVENTIONAL TYPES OF RADIATIONS AND THEIR IMPLICATIONS FOR NEUTRON THERAPY. Kligerman, Morton M. (Yale Univ., New Haven, Conn.). Eur. J. Cancer; 7: No. 2-3, 191-4(May 1971).

From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

Clinical characteristics for various groups of tumors are discussed with respect to response to fractionated treatments with supervoltage x rays and fast neutron treatments. It was thought that physical characteristics of supervoltage x ray beams, with small penumbra, skin sparing, and large depth dose, provide important advantages unlikely to be equalled by fast neutron beams. The usefulness of fast neutrons might be limited in cases where either a critical structure is near the tumor or where large areas of skin receive doses equal to the tumor dose. Different groups of tumors are listed which currently are highly curable or are not suitable for neutron treatment for other reasons, and others apparently suitable for neutron therapy are discussed, although methods were not available to predict their responses. (auth)

52161 CRITERIA FOR SELECTION OF TYPES OF TUMOURS FOR RADIOTHERAPY WITH UNCONVENTIONAL RADIATION. Kaplan, Henry S. (Stanford Univ. Medical Center, Calif.). Eur. J. Cancer; 7: No. 2-3, 195-7(May 1971).

From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

Criteria are discussed for the selection of appropriate types of tumors for randomized clinical trials to test the efficacy of fast neutron radiotherapy. A broad spectrum of human neoplasms was assessed as unsuitable, doubtful, or suitable for selection. Those considered unfavorable included those with the following characteristics: (1) High frequency of blood and bone metastases. (2) Too rare to provide practical numbers. (3) Too curable by conventional methods. (4) Benign or low grade malignancy. Tumors selected as probably favorable included various squamous cell carcinomas and also gliomas of the brain. (auth) (UK)

52162 POSSIBLE CLINICAL MODELS FOR QUANTITATIVE COMPARISON OF EFFECTS OF DIFFERENT RADIATIONS ON TUMOURS. Breur, K.; van Peperzeel, H. A. (Netherlands Cancer Inst., Amsterdam). Eur. J. Cancer; 7: No. 2-3, 199-203(May 1971).

From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

Clinical models which can provide quantitative data on the direct effects and on the RBE of fast neutrons compared to γ or x radiations in human tumors are discussed. It was suggested that pulmonary metastases offered the best possibilities for a comparative study of the therapeutic effects of photons and fast neutrons. (auth)

52163 INFLUENCE OF CELL PROLIFERATION IN TUMOURS AND NORMAL TISSUES DURING FRACTIONATED RADIOTHERAPY. Dutreix, J.; Tubiana, M.; Wamberise, A.; Malaise, E. (Inst. Gustave Roussy, Villejuif, France). Eur. J. Cancer; 7: No. 2-3, 205-13(May 1971).

From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

Proliferation rates of cells in human tumors and normal tissues were derived from clinical observations of x ray therapy. They were in agreement with experimental data obtained on animals. The proliferation rates did remain constant after irradiation or during the course of fractionated irradiation. Thus the usual regular fractionation did not seem optimally adopted to the kinetics of the cell populations. There was no evidence for any superiority of few and large fractions. (auth)

52164 EVALUATION OF PAST EXPERIENCE WITH FAST NEUTRON TELETHERAPY AND ITS IMPLICATIONS FOR FUTURE APPLICATIONS. Brennan, J. T.; Phillips, T. L. (Univ. of Pennsylvania, Philadelphia). Eur. J. Cancer; 7: No. 2-3, 219-25(May 1971).

From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

Past experience with fast neutron teletherapy of neoplasms is reviewed. The clinical applications of fast neutrons, initiated by Stone and Larkin at Berkeley from 1939 to 1944, were reexamined, and confirmed the conclusion that the patients had been overexposed. Details of four cases of the Stone–Larkin series are presented to illustrate the narrow reserve tolerance present in radiotherapy. The production of adequate beams for fast neutron teletherapy is discussed. In view of the limited penetration of 14 MeV neutrons, large sources to skin distances have to be employed, requiring a total yield of 4×10^{12} neutrons/sec produced by the D–T reaction. The characteristics of various types of D–T neutron generators are discussed in view of source strength and target life-time problems, and it is suggested that these might be solved by using a mixed deuterium–tritium beam and a bare copper drive-in target. The design features of such a neutron source are described. (auth)

52165 CLINICAL EXPERIENCE WITH FAST NEUTRONS FROM THE MEDICAL RESEARCH COUNCIL'S CYCLOTRON AT HAMMERSMITH HOSPITAL. Catterall, Mary (Hammersmith Hospital, London). Eur. J. Cancer; 7: No. 2-3, 227-9 (May 1971).

From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

Forty patients suffering from advanced malignant tumors of the breast, head, neck, and skin were treated with 7 MeV fast neutrons from the M.R.C.'s cyclotron at Hammersmith Hospital. The machine has an output of 40 rads/min and treatment times did not exceed 4 min. Ten of the patients had multiple or very large tumors and were treated also with gamma x radiation. The responses of the skin in the treated areas to the two types of radiation were observed and the reactions quantitated to obtain the RBE of fast neutrons and x radiation, for effects on skin. It appeared to be approximately 2.9. A skin sparing effect was demonstrated. The tumors were measured as objectively as possible and rates of regression recorded. These varied among different histological types and also in the same patient when multiple nodules were treated with both types of radiation. All the tumors treated with neutrons showed a favorable response not qualitatively different from that seen with low LET radiation. (auth)

52166 CONSIDERATIONS IN PLANNING A CLINICAL TRIAL WITH FAST NEUTRONS. Withers, H. R.; Almond, P. R.; Brown; B. W. (Univ. of Texas, Houston). Eur. J. Cancer; 7: No. 2-3, 231-5(May 1971).

From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

The problems of instituting a clinical trial of fast neutron therapy are discussed. The characteristics of the fast neutron beam of a cyclotron at Texas A&M University are outlined. (auth)

52167 POSSIBILITIES FOR THE APPLICATION OF FAST NEUTRONS IN MANCHESTER. Duncan, W. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Eur. J. Cancer; 7: No. 2-3, 237-40(May 1971).

From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

The experimental 14 MeV neutron generator facility at the Christie Hospital, Manchester, is described, and the main features of the design, a new neutron therapy machine, are reported. Experiments have been started to determine the RBE for effects on skin of selected patients, to be followed by a study of the effects of neutrons on other normal tissues. Formal clinical trials should have been started in 1971 and the choice and stage of tumors to be studied are detailed. (auth)

52168 INFLUENCE OF THE SIZE OF THE FRACTION DOSE ON NORMAL AND TUMOUR TISSUE IN ^{60}Co RADIATION TREATMENT OF CARCINOMA OF THE LARYNX AND INOPERABLE CARCINOMA OF THE BREAST. Kok, G. (H. Joannes de Deo Hospital, The Hague). Radiol. Clin. Biol.; 40: No. 2, 100-15 (1971).

A description is given of some fundamental aspects of fractionation in relation to cell cycle time and recovery in various normal and tumor tissues. Experiences with several fractionation schemes for telecobalt treatment of carcinoma of the larynx (stage I) and of inoperable carcinoma of the mamma are evaluated on this basis. This leads to strong indications that the size of the fraction dose is highly critical for both tumor and surrounding tissue. For each tumor, the treatment technique employed is described in detail and for each a particular fractionation scheme is recommended. (auth)

52169 TREATMENT OF THE CHEEK MUCOSA CARCINOMA. Danczak, Z. Nowotwory; 21: No. 2, 155-61(1971). (In Polish).

Sixty six patients with cheek mucosa carcinoma were treated in the Oncological Institute in Warsaw during 1947 to 1964. Five-year recovery was observed in 38 patients (57.7%). Out of 45 patients, 10-years recovery was obtained in 24 (48.8%). The most effective results were achieved by interstitial treatment with ^{198}Au. The results of treatment with radium and with superficial apparatus are similar (recurrences–10%; necroses–20%). Use of the superficial apparatus should be abandoned due to a greater irradiation hazard of the staff. In the case of clinical symptoms of metastases into lymph nodes of the neck, it is advisable to perform surgical treatment by means of the method of Crile-Jawdyński. Metastases into lymph nodes were microscopically detected in 5 out of 16 operated cases. The most frequent cause of failures in treatment was recurrence in the primary focus and ineffective therapy (26.6%). Failures because of metastases to the lymph nodes of neck were observed in 10.6% of patients. In considerably advanced cases, irradiation with ^{60}Co is justifiable (35.7% of 5-year recoveries). (auth)

52170 ENIGMA OF NASOPHARYNGEAL CANCER. A SELECTIVE REVIEW INCORPORATING LOCAL EXPERIENCE. Peters, L. J. Australas. Radiol.; 15: No. 2, 123-30(May 1971).

Literature on the incidence, etiology, and histogenesis of nasopharyngeal cancer is reviewed and an attempt is made to reconcile divergent theories. A survey is made of cases treated at the Queensland Radium Institute in the period 1950 to 1969, and techniques of treatment are described. Modifications to the field arrangements of dosimetry are described and isodose diagrams are given. Megavoltage radiation has not significantly increased survival rates but has considerably reduced the morbidity of treatment. (Australia)

52171 RESULTS OF TREATMENT OF CARCINOMA OF THE CERVIX IN WESTERN AUSTRALIA. Holt, J. A. G. Australas. Radiol.; 15: No. 2, 164-7(May 1971).

An analysis is made of survival patterns of patients who received combined surgical and radiotherapeutical treatment of cervical cancer. The survey covered the period 1953 to 1968 and involved 461 patients. The survey is divided into groups having received various degrees of surgery combined with differing radiation treatments. (Australia)

52172 RADIOTHERAPY OF MALIGNANT BLADDER TUMORS. Heckenthaler, W. (Univ., Vienna). Wien. Klin. Wochenschr.; 83: No. 27-28, 525-6(9 Jul 1971). (In German).

Problems in the radiotherapy of malignant bladder tumors are analyzed. A dose of 6000 R is required for deep-seated tumors. In conventional x-ray therapy, this dose adversely affects neighboring tissues, skin, and also can cause shrinkage of the bladder. Cobalt-60 teletherapy is considered the most effective method for treatment of bladder tumors; doses are more evenly distributed and, therefore, cause less harmful side effects. (H.B.G.)

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52173 ISOTOPE THERAPY OF THYROID CARCINOMAS. Hoefer, R. (Univ., Vienna). Wien. Klin. Wochenschr.; 83: No. 27-28, 512-13(9 Jul 1971). (In German).

The radiography of thyroid carcinoma with ^{131}I is discussed. A method is described for the determination of the retained radioiodine, indicating presence, size, and location of possible metastases. A case is presented in which a patient with lung metastases received 150 mCi ^{131}I. Seventy-two hours later, 13% of the dose was still retained in the body; a sufficient amount to successfully eliminate the metastases. It is recommended that surgery, chemotherapy, and radiation be used together with ^{131}I for treatment of thyroid carcinomas, especially in cases where metastases are suspected. (H.B.G.)

Blast and Thermal Effects

Refer also to abstract 52185.

Radiation Effects on Animals

Refer also to abstracts 51713, 51992, 52008, 52077, 52106, and 52112.

52174 (A/CONF.49/P–30) RECENT RESULTS OF FAST-NEUTRON RADIOBIOLOGY AND THEIR SIGNIFICANCE FOR RADIATION PROTECTION AND TUMOUR RADIOTHERAPY. Davids, J. A. G. (Reactor Centrum Nederland, Petten); Barendsen, G. W.; Broerse, J. J. May 1971. 25p. (CONF-710901–77). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Dose-effect relations for damage to mammalian cells, tissues and organisms by fast neutrons of different energies have been determined during the past several years with various techniques. The results have shown: Fast neutrons are per unit dose generally more effective for damaging cellular proliferation than x-rays and γ-rays i.e. the relative biological effectiveness (RBE) is larger than 1 and increases with decreasing neutron energy. Accumulation damage, as demonstrated by the shapes of cell survival curves, is smaller with fast neutrons than with x-rays and γ-rays. Correlated with this phenomenon is the smaller contribution of repair of sub-lethal damage after fast-neutron irradiation and the consequent small effect of fractionation of the dose and of changes of the dose-rate. The RBE is generally largest for small doses and low dose-rates. Damage produced by fast neutrons is less modified by conditions of the cells e.g. the presence of oxygen or cell age. Quantitative data demonstrating these general conclusions will be discussed for cultured cells, and experimental animals irradiated with fission-spectrum fast neutrons with a mean energy of 1 MeV and with 15 MeV neutrons produced by the ^{3}H(d,n)^{4}He reaction. With respect to quality factors to be used for radiation protection, extrapolation to low doses and low dose-rates is required on the basis of insights in mechanisms of action of fast neutrons obtained from experiments at relatively high doses. In tumor therapy fast neutrons provide an advantage over x-rays only if RBE values are larger for effects on normal tissues. Such differences may arise due to partial anoxia of cells in a tumor, while normal tissues are well oxygenated. In addition repair of sub-lethal damage depends on the types of cells and on the neutron energy spectrum, providing additional possibilities to discriminate between tumors and normal tissues. (auth)

52175 (A/CONF.49/P–163) RECOVERY FROM RADIATION DAMAGE IN BIOLOGICAL SYSTEMS. James, A. P.; Rixon, R. H.; Whitfield, J. F. (National Research Council of Canada, Ottawa (Ontario)); Newcombe, H. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1971. 15p. (CONF-710901–180). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In Canadian research establishments, many investigations of the biological effects of radiation are now concerned with recovery mechanisms at the molecular, cellular, and population levels. The object of these studies is to obtain information which may eventually permit control of natural recovery processes. At the molecular level, the exceptionally efficient repair systems of Micrococcus radiodurans are being used to elucidate the sequence of events leading to excision repair. In other organisms, including Escherichia coli and yeast, mutant strains with altered sensitivity to radiation are providing insight into the complex relationships between pre- and post-replication repair of DNA lesions, genetic recombination, induced mutation, and lethality. In yeast, attention is also being concentrated on recovery from the induced propensity for lethal sectoring, one of the more common but least conspicuous types of lethal damage. Data now indicate that recovery occurs through a multiple-step mechanism which involves genetic recombination. Methods of influencing the repair of non-genetic damage at the levels of the cell and the organism are being developed using mammalian cell systems. It has been found that radiation unleashes a respiration- and phosphate-dependent reaction which eventually leads to dissolution of nuclear chromatin structures. These reactions can be influenced by changing the extracellular phosphate concentration both in vivo and in vitro. Recovery of the irradiated animal can be promoted by postirradiation administration of parathyroid hormones or of compounds which induce their release from the parathyroid gland. At the population level, where recovery from genetic damage involves reproductive superiority of non-mutants, animal experiments with both fish and rats are providing information on the stage in the life cycle at which elimination of induced harmful mutation is most likely to occur. In man, related information is being obtained from the correlations which exist between parental fertility and naturally-occurring mortality and morbidity of embryos and children. (auth)

52176 (A/CONF.49/P–358) EFFECT OF GAMMA RAYS AND HIGH ENERGY ELECTRONS ON DEVELOPMENT AND MITOSIS OF MALIGNANT CELLS. Neskovic, B. A.; Djuric, Lj.; Polic, Dj.; (and others) (Medical Faculty, Belgrade). May 1971. 8p. (CONF-710901–122). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The effects of 700 rads ^{60}Co gamma radiation on the fibrosarcoma L-cells in vitro and fast electrons of 5 to 42 MeV are discussed. The analysis of radiation effects was performed on the level of one cell in the various developmental mitotic and intermitotic phases on the basis of criteria established by one of the authors. The previously published results of the authors about the effects of 770 rads ^{60}Co gamma radiation demonstrated that the early postmitotic developmental phases (N, S, As, La$_1$), representing G$_1$ period, are the most sensitive in the relation to their mitotic ability in the first mitosis following radiation exposure. The last results of the authors also demonstrated that the cells irradiated in these phases with the same technique and doses had very reduced survival rate and recovery ability. The authors also analyzed the synthesis rate of DNA, RNA, and proteins by autoradiographic methods in irradiated cells. Comparing the effects of the same doses of ^{60}Co gamma radiation and high-energy electrons it was demonstrated that there was a higher efficacy of fast electrons in the early radiation effects. At the end will be discussed the effects of high-energy electrons on the synthesis rate of DNA, RNA, and proteins. (auth)

52177 (A/CONF.49/P–554) RADIATION DAMAGE AND REPAIR OF ANIMAL CELLS. Drasil, V.; Karpfel, Z.; Juraskova, V.; Ryznar, L. (Czechoslovak Academy of Science, Brno). May 1971. 22p. (CONF-710901–241). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Radiation damage induced by rtg radiation was studied in animal cells using mice L-cells, diploid and tetraploid Ehrlich ascites tumor cells (EAT), and mice lymphosarcoma LS/BL cells. These cells exhibited approximately the same sensitivity to x-irradiation. Their D$_0$ values varied between 100 and 160 rads. While L- and EAT cells produced giant forms after irradiation, intermitotic death and disintegration of LA/BL cells was observed a few hours after irradiation. The survival curves were followed and the changes in molecular weight of cellular DNA were investigated immediately after irradiation. The damage to DNA was studied by centrifugation in neutral and alkaline sucrose-gradients. Results showed that the evidence of single breaks in the macromolecular DNA after doses higher than 100 rads was possible. A few hundred rad dose led to the decrease of sedimentation constant of DNA centrifuged in neutral sucrose-gradient, demonstrating the presence of double breaks in the macromolecule. Comparing the survival curves with the damage of DNA, it was pointed out that there was not a simple correlation between above mentioned phenomena. Calculation of energy (absorbed in DNA) corresponding to the formation of one single or double break showed results which differed for individual cellular types. Extremely low values were found in LS/BL cells. In this case, a double break was already formed after absorption of 14 eV in the macromolecule. Detailed study of such unexpected phenomena leads to the conclusion that the primary effect of radiation on DNA is enzymatically increased by nucleases. At present, it is not clearly known whether it is an enzyme released by radiation from some of cellular structures, or, whether surplus excision of damaged parts of DNA is exhibited. In another experimental part the repair ability of cells and their reactions to irradiation were followed. Application of exogenous isologous macromolecular DNA was positive. The study on the mechanism of this effect is now in progress. (auth)

52178 (RLO-2226-T-1-6) STUDIES OF GENETIC ALTERATIONS IN HUMAN CELLS AND MOLECULES AND THE FACTORS INFLUENCING THEM. **Progress Report for the Period, August 1, 1970–July 31, 1971. (Oregon Univ., Portland. Div. of Medical Genetics). Contract AT(45-1)-2226. 96p. Dep. NTIS.**

Structural studies of phytohemagglutinin included dissociation into subunits, molecular weight of subunits, separation of subunits, and primary structure. Studies on the nature of the mitogenic factor of phytohemagglutinin included alterations of the molecular conformation of the phytohemagglutinin and effects of proteolytic enzymes. Studies were also conducted on the mechanism of the mitogenic action of the phytohemagglutinin and the relationship of structure to function of the phytohemagglutinin. Studies on effects of x radiation on lymphocyte transformation included effects of various doses; effects of x radiation on the dose response to phytohemagglutinin; effects of x radiation on the time response to phytohemagglutinin; effects of x rays on lymphocytes irradiated at various intervals of time following their stimulation by phytohemagglutinin; and effects of preirradiation of lymphocytes with x rays on their response to phytohemagglutinin. The effect of immunogenic synthetic polyribonucleotides on lymphocytes was investigated with regard to the response of lymphocytes to phytohemagglutinin. (H.L.W.)

52179 (UCSF-10-P-2-134) IMPORTANCE OF REPAIR REPLICATION FOR MAMMALIAN CELLS. **Painter, Robert B. (California Univ., San Francisco. Lab. of Radiobiology). [1971]. Contract AT(11-1)-Gen-10. 5p. (CONF-710910-1). Dep. NTIS.**

From first European biophysics congress; Baden, Austria (14 Sep 1971).

Cultures of mouse L cells were irradiated with 0, 1000 R, and 10,000 R of x radiation. Repair replication was detected by the presence of tritium (from ^{3}HBUdR) in normal density DNA. Graphs are presented to show profiles of third rebands in single-stranded DNA. It was found that a dose of 1000 R did not, but that a dose of 10,000 R did induce repair replication to a greater extent than that in controls. The observations suggest that x irradiation of mammalian cells causes single-strand DNA breaks which are repaired without extensive widening of the gaps. It is thought that the repair system acts to correct constantly low level damage occurring as a result of normal metabolic action. (H.L.W.)

52180 EFFECT OF X RAYS ON THE RNA METABOLISM IN EHRLICH ASCITES TUMOR CELLS. **Trams, G.; Maass, H.; Kirschbaum, E. (Univ., Hamburg). Biophysik; 7: 259-68(1971). (In German).**

The metabolism of RNA in irradiated Ehrlich ascites tumor cells was studied in vitro. It was found that the total RNA synthesis in mammalian cells is hardly affected by irradiation. In further experiments cell nuclei were prepared and two RNA fractions with different base composition were isolated. It was observed that the H^3-uridine incorporation into the 65°C fraction decreased at the dose range of 1000 to 1500 R, whereas the 50°C fraction showed no marked changes in RNA synthesis. Experiments on the effects of irradiation on newly synthesized RNA (chase-experiments) produced no observable degradation of RNA. (auth)

52181 POTENTIATION OF X-RAY KILLING BY 5-BROMODEOXYURIDINE IN CHINESE HAMSTER CELLS: A REDUCTION IN CAPACITY FOR SUBLETHAL DAMAGE ACCUMULATION. **Shipley, W. U.; Elkind, M. M.; Prather, W. B. (National Cancer Inst., Bethesda, Md. Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 47: No. 2, 437-49(Aug 1971).**

Chinese hamster cells grown, treated, and assayed in culture were used to study the enhanced cell killing that results when cells are irradiated containing the thymidine analogue 5-bromodeoxyuridine. Under exponential growth conditions, which probably result in unifilar or bifilar substituted DNA, such cells have reduced ability to recover between two fractionated doses. Studies with synchronized, maximally resistant, late S-phase cells confirmed that the main effect of 5-bromodeoxyuridine incorporation is to reduce a cell's capacity to accumulate sublethal damage rather than to reduce its ability to repair such damage. (auth)

52182 COMPARISON OF UNSCHEDULED DNA SYNTHESIS, D_0, CELL RECOVERY, AND CHROMOSOME NUMBER IN X-IRRADIATED MAMMALIAN CELL LINES. **Shaeffer, James; Merz, Timothy (Johns Hopkins Univ., Baltimore). Radiat. Res.; 47: No. 2, 426-36(Aug 1971).**

The relative extent of x-ray-induced unscheduled DNA synthesis was measured in seven mammalian cell lines: HeLa, mouse L-929, rat kangaroo kidney, human embryonic kidney, human laryngeal tumor, rat kangaroo liver, and human peripheral lymphocyte. Radiosensitivities (D_0) and recovery ratios were measured in the HeLa, mouse L-929, and rat kangaroo kidney lines. There was no apparent correlation between unscheduled DNA synthesis and radiosensitivity or recovery ratio in these cell lines. These observations are consistent with the conclusion that cell survival after x-irradiation is not solely, if at all, dependent on unscheduled DNA synthesis. A correlation was observed between the relative amount of unscheduled DNA synthesis in the cell lines studied and their modal chromosome number. Cell lines containing more chromosomes showed greater amounts of unscheduled DNA synthesis. No correlation was apparent, however, when unscheduled DNA synthesis was compared with DNA content. One cell line, the rat kangaroo kidney line, showed no apparent unscheduled DNA synthesis. Whether this absence of unscheduled synthesis is the result of an enzymatic deficiency or is the natural consequence of a low chromosome number (11) is not clear and warrants further investigation. (auth)

52183 RADIATION-INDUCED AGE-RESPONSE CHANGES IN CHINESE-HAMSTER CELLS. EVIDENCE FOR A NEW FORM OF DAMAGE AND ITS REPAIR. **Elkind, M. M.; Kano, E. (Brookhaven National Lab., Upton, N. Y.). Int. J. Radiat. Biol.; 19: No. 6, 547-60(1971).**

Chinese-hamster cells synchronized at the G_1–S border by treatment with hydroxyurea have a small ability to accumulate sublethal damage, and their fractionation response is consistent with this. However, the effect of a single x-ray dose remains fixed long enough to prevent full development of the capacity for sublethal damage, which normally reaches a maximum in late S. Thus, radiation modulates the normal age-response pattern, although tests of the properties of progeny of G_1–S survivors show that this decoupling is transient. (A similar result is obtained when the test is applied to the offspring of cells irradiated in S and G_2.) Thus, in addition to an ability to repair sublethal damage, Chinese-hamster cells have a self-stimulated ability to re-establish their normal variation of radiation response with cell age. (auth)

Invertebrates

Refer also to abstracts 51999, 52007, and 52031.

52184 (A/CONF.49/P-2) INHERITED STERILITY IN THE FIG MOTH, CADRA (EPHESTIA) CAUTELLA WALKER. **Ahmed, M. S. H.; Al-Hakkak, Z.; Al-Saqur, A. (Atomic Energy Commission, Baghdad (Iraq). Nuclear Research Inst.). Apr 1971. 12p. (CONF-710901-259). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Following the administration of several sub-sterilizing doses of gamma-radiation to fig moths (Ephestia cautella Walk.) different percentages of inherited sterility in the F_1 generation have been obtained. Generally, adult F_1 males from progeny of a male fig moth that received a sub-sterilizing dose of gamma-radiation, mated with untreated virgin females produced a higher sterility level than that of the parent generation. Preliminary studies indicated that normal fertility has been restored in F_2 progeny of male parent irradiated with 20 krad. Egg hatchability of the progeny of treated fig moths with different doses of gamma radiation have been studied and compared with that of the control (untreated moths). It has been concluded that the sterile-insect technique might be effective in controlling this lepidopterous insect (fig moth) through induced inherited sterility by sub-sterilizing doses of the mutagens. A simple method of rearing was worked out to provide sufficient number of insects for the present experiments. (auth)

Vertebrates

Refer also to abstracts 51965, 51970, 51971, 51976, 51977, 51991, 51998, 52005, 52006, 52026, 52027, 52097, 52107–52111, 52113–52117, and 52268.

52185 (AD-721094) EFFECTS OF IRRADIATION AND BLAST ON PULMONARY FUNCTION IN SHEEP. **Technical Progress Report. Yelverton, John T.; Damon, Edward G.; Jones, Robert K.; Chiffelle, Thomas L.; Luft, Ulrich C. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Jan 1971. Contract DA-49-146-XZ-359. 32p. (DASA-2630). NTIS.**

The changes in pulmonary function that result following unilateral exposure to LD50 doses of neutron-gamma irradiation and/or sublethal blast overpressures were investigated in sheep. Animals exposed to blast-only and radiation-plus-blast demon-

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strated large increments in venous admixture on the day of insult followed by a major recovery toward baseline values during the first 24 hrs following injury. The venous admixture of the blast-only animals approached baseline 7 days after exposure but that of the radiation-plus-blast sheep did not return to baseline until 21 days. The sheep exposed to radiation-only, blast-only, and radiation-plus-blast sustained similar reduction in mean carbon monoxide diffusing capacity (DL—CO) that was below that of the control mean at 2 days and 7 days post exposure. All of the radiation-only and radiation-plus-blast sheep that survived to or beyond 21 days displayed an overshoot or recovery to their individual baseline DLCO values. The blast-only and radiation-plus-blast animals also exhibited an increased mean ineffective alveolar ventilation (VAIneff) that persisted from 1 to 14 days following the onset of trauma. The radiation-only sheep had an increased VAIneff from 2 through 7 days post exposure. (auth)

52186 INFLUENCE OF BIS (-3-HYDROXPROPYL) TRISULFIDE ON THE PERIPHERAL BLOOD IN RATS AFTER HIGH DOSES OF X RADIATION. Zebro, Tadeusz; Kowalczykowa, Janina; Mirek, Teresa; (and others). Patol. Pol.; 21: No. 2, 225-36(Apr-Jun 1970). (In Polish).

The influence of bis(-3-hydroxypropyl) trisulfide in rats irradiated on the whole body with 420 R of x rays was studied. Experiments were carried out with four groups of hooded rats: a group irradiated but not treated with the trisulfide, a group irradiated 8 min after receiving a dose of 50 mg/kg body weight, and a third group treated with the compound but not irradiated. The peripheral blood of the rats was examined on the day preceding irradiation and in the course of 98 days after irradiation. The blood from a control group of rats was also studied. Red and white blood cells and reticulocytes were counted, percentages of white blood cells were determined, and the hematocrit and hemoglobin were assayed. Electrophoresis of serum proteins was also performed. (auth)

52187 INFLUENCE OF SPACE DISTRIBUTION OF THE ABSORBED ENERGY ON THE EFFECT OF EXTERNAL IONIZING RADIATION ON THE DEVELOPMENT OF RADIATION INJURY. Darenskaya, N. G.; Avetisov, G. M. Radiobiol.-Radiother.; 11: No. 1, 27-34(1970). (In German).

The development of the clinical picture of radiation injury was analyzed in 750 rats in relation to the dose absorbed during partial-body x-irradiations by comparison of the values in the different regions of the body. The possibility of predicting the prognosis of the course of the radiation sickness under the conditions of partial irradiation in relation to sufficient dosimetric information was also shown. (auth)

52188 EFFECT OF SMALL DOSES OF RADIOIODINE ON THE MOTILITY OF SPERMATOZOA IN VIVO. Massalski, W.; Gorowski, T.; Janczewski, Z.; Chomicki, O. (Medical Clinic, Warsaw). Radiobiol.-Radiother.; 11: No. 1, 41-4(1970).

The effect of small doses of ^{131}I given subcutaneously to mice on the motility of sperm was studied. The doses of 0.05, 0.1, and 5.0 μCi were calculated in relation to the body weight in man, i.e., 0.1 μCi in the mouse would correspond to about 300 μCi in man. The epididymis contents was obtained and examined. The number and the motility of the sperm were determined, and stained smears were also examined. Immotility was found following doses of 0.1 μCi and 5.0 μCi, which lasted for more than 17 days. The control groups showed no change in their spermatozoa motility. Changes in the motility may manifest an early damaging effect of ^{131}I. (auth)

52189 ACTIVITY OF FRUCTOSE 1.6-DIPHOSPHATE-ALDOLASE (EC 4.1.2.13) AND OF PHOSPHOGLUCOISOMERASE (EC 5.3.1.9) IN THE SERUM OF RATS AFTER WHOLE-BODY X IRRADIATION. Roesler, B. (Medizinische Akademie, Magdeburg, Ger.). Radiobiol.-Radiother.; 11: No. 1, 73-84 (1970). (In German).

After whole-body x-irradiation with doses of 400 R up to 1000 R of male and female rats the activity of fructose 1.6-diphosphate-aldolase and of phosphoglucoisomerase was studied up to the 30th day. A gradual decrease was observed in serum aldolase and only in the female rats a significant increase was found in the phase of restitution. In phosphoglucoisomerase an increase of enzymatic activity was observed in the gastrointestinal phase, and in the phase of restitution, both sexes being found poor in symptoms during the interval. (auth)

52190 HISTOLOGICAL AND HISTOCHEMICAL OBSERVATIONS ON THE ADRENALS OF RATS AFTER LOCAL AND WHOLE-BODY IRRADIATION. Unger, E. Radiobiol.-Radiother.; 11: No. 6, 737-48(1970). (In German).

Morphological changes in the adrenals of rats were studied using various histological and histochemical methods at different dates after exposure to doses of 5000 R to 8000 R local and 600 R to 800 R whole-body x radiation. The changes observed were slight and confirmed the relative morphological radiation resistance of the adrenals. (auth)

52191 SEASONAL INFLUENCE ON DAILY PERIODICITY OF THE RADIOSENSITIVITY OF MICE. Kuznetsova, S. S. Radiobiol.-Radiother.; 11: No. 5, 611-19(1970). (In German).

Daily fluctuations of radiosensitivity were followed in six experiments using 1220 mature hybrid mice. The animals were kept under conditions of natural daylight and at night artificial light, with morning feeding and were irradiated in groups (17 to 25 animals) with a dose of 580 R x radiation at intervals of three hours beginning at nine o'clock. The general radiosensitivity was judged according to lethality within 30 days after irradiation. Periodical fluctuations of radiosensitivity appeared during the course of the day. The difference between the maximum and the minimum values of lethality was significant in all cases. A seasonal influence on the character of the daily periodicity of radiosensitivity of mice was found. In summer this periodicity was two-phase, whereas in winter it was one-phase. Obviously, these differences were caused by changes in the proportion of the bright and dark time of day during the course of a year. An important role in the formation of the rhythm of radiosensitivity was also played by the factor of feeding. It was concluded that the observed rhythm of radiosensitivity was related to the normal physiological fluctuations of the metabolic processes during the day. (auth)

52192 IMMUNOELECTROPHORETIC EXAMINATIONS OF THE EFFECT OF WHOLE-BODY IRRADIATION ON THE SERUM PROTEIN CONTENT OF JUVENILE RATS. Neumeister, K.; Mehlhorn, G.; Koch, F.; Panndorf, H.; Johannsen, U. (Karl-Marx-Univ., Leipzig). Radiobiol.-Radiother.; 11: No. 4, 465-9 (1970). (In German).

The effect of a whole-body x irradiation of 600 R on the content of the serum proteins of juvenile rats was examined in relation to time after irradiation. It was shown that in juvenile rats changes in the serum protein picture were caused by irradiation that varied from those in adult animals. From the 6th day after irradiation the concentration of albumin and transferrin was increased compared with the controls. The haptoglobin not present in normal development before the 11th day after birth was found in irradiated rats of 7 days of age. From the 8th day after irradiation the fraction of γ_G-globulin was decreased. (auth)

52193 RADIATION EFFECTS AND ADRENAL CORTEX. VI. POLYPHASE INCREASE OF CORTICOSTEROIDS IN RATS AFTER WHOLE-BODY IRRADIATION. Geierhaas, B.; Flemming, K. (Univ., Freiburg i. B.). Radiobiol.-Radiother.; 11: No. 2, 215-19(1970). (In German).

The pattern of corticosteroids in the suprarenals and in the peripheral blood was examined in rats up to 30 days after x irradiation. It was found that the changes of corticosteroids in the suprarenals and in the blood were the same during the first half of the experiment or up to the 13th day. From the 15th day the values of blood and suprarenals were different. During the first half of the experiment the corticosteroids in the suprarenals and in the blood increased on the 3rd, 5th and 11th day after irradiation. The increase on the 3rd day was much more intensive than the increase following later. During the second half of the experiment the corticosteroids increased in the suprarenals on the 24th day after irradiation; the levels of the blood were at the level of the controls. The possible causes of the polyphase activation of the adrenal cortex in the course of radiation sickness are discussed with regard to the idea of stress. (auth)

52194 SOME QUESTIONS TO THE EFFECT OF IONIZING RADIATION ON THE ENDOCRINE GLANDS AND ITS RELATION TO THE RADIATION SYNDROME. Grodzenskii, D. E. (Inst. of Epidemiology and Microbiology, Moscow). Radiobiol.-Radiother.; 11: No. 2, 207-13(1970). (In German).

Results are reported from studies on the effects of ionizing radiation on the endocrine system and its relation to the development of the radiation syndrome. Functional distrubances of the pituitary gland and of the adrenal cortex following exposure of rats to lethal doses of x radiation are described. The rats of synthesis of adrenocorticotropic hormone (ACTH) in the pituitary gland did not change following irradiation, the biological half-life of ACTH did not change, and there was no increase in the content of ACTH in the peripheral blood. No changes in the function of the adrenal cortex were observed during the terminal period of radiation sickness. (auth)

52195 EFFECT OF SMALL DOSES OF ROENTGEN RAYS ON THE CENTRAL NERVOUS SYSTEM. Vasculescu, T.; Papilian, V. V. (Medical-Pharmaceutical Inst., Cluj). Radiobiol.-Radiother.; 11: No. 5, 629-42(1970). (In German).

Seventy-five rats received 50 R of 160 kV x radiation to the head. The dose was administered with either single or fractionated exposure. At various times following irradiation, the brain was histologically studied using various staining methods. Histological changes were pronounced in the hypothalamus, much smaller in the cerebellum, and barely noticeable in the cerebral cortex. The histological changes consisted in a decrease of cytoplasmic RNA and extracellular changes. Unchanged were nuclear RNA, DNA, myelin, and the vascular system. (H.B.G.)

52196 LiF THERMOLUMINESCENCE DOSIMETRY OF RATS DURING PARTIAL AND WHOLE-BODY IRRADIATIONS. Reichel, G.; Schmidt, W.; Morczek, A.; Schuenzel, G. (Medizinische Akademie, Magdeburg, Ger.). Radiobiol.-Radiother.; 11: No. 5, 643-8(1970). (In German).

Considerable differences were observed in the peripheral blood picture of rats after partial- or whole-body x irradiation. These differences are expected to increase in more highly organized animals, based on the changed relations of the geometrical site of the organs. The measured radiation doses to the organs give valuable data that may be extrapolated to higher animals. In the interest of comparability of experimental results the radiobiological data should be combined with data on the specific organ dose. Data on the dose of x radiation observed by various tissues in rats, measured using implanted LiF thermoluminescent detectors, are compared with data on the leukocyte count in peripheral blood. (auth)

52197 RADIOTOXINS AND THEIR PART IN PATHOGENESIS OF RADIATION SICKNESS. Kocmierska-Grodzka, D. (Medizinische Akademie, Bialystok, Poland). Radiobiol.-Radiother.; 11: No. 3, 265-76(1970). (In German).

The origin and pathological effects of toxic substances called radiotoxins (RT), which occur following irradiation of plant and animals, are discussed. The results of investigations on the influence of inhibitors of proteolytic enzymes on the development of postirradiation toxemia in rats are reported. The data point to the fact that parallel with the increased proteolytic activity of tissues of irradiated animals, the increase of toxins of the o-chinon type was observed. The decrease of postirradiation proteolysis following the treatment of animals with antiproteolytics was closely connected with the decrease of postradiation toxemia. (auth)

52198 RESPONSE OF A POORLY REOXYGENATING MOUSE OSTEOSARCOMA TO X-RAYS AND FAST NEUTRONS. van Putten, L. M.; Lelieveld, P.; Broerse, J. J. (Radiobiological Inst. TNO, Rijswijk, Netherlands). Eur. J. Cancer; 7: No. 2-3, 153-60(May 1971).
From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

A transplantable mouse osteosarcoma, previously shown to reoxygenate its anoxic cells very slowly after a single large dose of x rays, was studied after x and fast neutron irradiation. It was relatively resistant to fractionated x ray therapy, probably due to anoxia, but it could be shown that a small degree of reoxygenation occurred. Its response to treatment with 15 MeV neutrons was unusual; RBE values for cell survival of 10^{-3} were for fractionated irradiation 2.5, for single dose in vivo irradiation 1.8, and for in vitro irradiation 1.6. The small difference between the RBE values for the well oxygenated osteosarcoma cells in vitro and for the partially hypoxic cells in vivo was associated with an unexpectedly high OER of 2.0 for neutron irradiation of these cells in vitro as compared with the OER for x rays of 2.4. The gain factor for neutrons, that is the ratio of OER values for x rays and neutrons, was 1.2, indicating that although hypoxia may be a limiting factor for the cure of this tumor by fractionated x rays, the use of neutrons did not offer a major advantage. (auth)

52199 RBE VALUES FOR CYCLOTRON NEUTRONS FOR EFFECTS ON NORMAL TISSUES AND TUMOURS AS A FUNCTION OF DOSE AND DOSE FRACTIONATION. Field, S. B.; Hornsey, S. (Hammersmith Hospital, London). Eur. J. Cancer; 7: No. 2-3, 161-9(May 1971).
From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

For various normal tissue endpoints, the RBE was shown to vary with size of dose and with the differential amount and rate of repair of sublethal damage for each tissue. The RBE for late damage in skin and neoplasms was shown to be the same as for early damage, for single and fractionated exposures. For all treatments, once above a certain dose level, a small increase in dose led to a small increase in early reaction, but resulting in a very large increase in late damage. Neutrons were a more effective treatment than x rays for experimental tumors whose response is limited by hypoxic cells, but in some cases, the use of properly fractionated doses of x rays was equally efficient. (auth)

52200 RBE VALUES OF 15 MeV NEUTRONS FOR EFFECTS ON NORMAL TISSUES. Broerse, J. J.; Barendsen, G. W.; Freriks, G.; van Putten, L. M. (Radiobiological Inst. TNO, Rijswijk, Netherlands). Eur. J. Cancer; 7: No. 2-3, 171-7(May 1971).
From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

RBE values of 15 MeV neutrons are compared with 300 kV x radiation for effects on cell survival in normal mouse bone marrow, mouse intestine, and rat skin. In general it was found that the values were lower than the RBE values for effects on animal tumors. (auth)

52201 CELLULAR RESPONSES DETERMINING THE EFFECTIVENESS OF FAST NEUTRONS RELATIVE TO X-RAYS FOR EFFECTS ON EXPERIMENTAL TUMOURS. Barendsen, G. W. (Radiobiological Inst. TNO, NO, Rijswijk, Netherlands). Eur. J. Cancer; 7: No. 2-3, 181-90(May 1971).
From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

Relations between the relative biological effectiveness (RBE) of fast neutrons and x radiation, the dose, and daily dose fractions are presented for cultured cells, tumors, and normal tissues. These were dependent on the neutron energy spectrum, the shapes of dose-survival curves, repair of sub-lethal damage, the presence of anoxic cells, reoxygenation during intervals between dose fractions, and the dependence of radiosensitivity on the age of cells in their cycle. The relative influence of these factors is discussed. (auth)

52202 VARIATION OF CYTOCHROME c PEROXIDASE ACTIVITY IN THE PRESENCE OF IRRADIATED AND RADIOSENSITIZED TISSUES. Dinescu, Gabriela; Mihai, Cornelia (Oncological Inst., Bucharest). Rev. Roum. Biochim.; 8: No. 1, 39-45(1971).

Some biochemical changes induced by irradiation under radiosensitizing conditions in normal rat tissues and Jensen sarcomas were studied; tumor radiosensitization was performed by local tumor irradiation under conditions of decreased pH (by glucose administration) and catalase inhibition (with 3-amino-1,2,4-triazole (AT). In vitro irradiation of tumor homogenates at pH 6 led to an increase in the damaging effect of H_2O_2 formed during irradiation (in comparison with physiological pH); estimation was done by determining the amount of cytochrome c decomposed under the action of H_2O_2, and was 70% higher in solutions irradiated at pH 6 than at pH 7.4. Combination of irradiation with a catalase inhibitor (AT) led to an increase in cytochrome c peroxidasic activity in brain and spleen homogenates from treated animals. Jensen sarcomas irradiated in vivo under radiosensitizing conditions presented a slight decrease in succinoxidase activity and cytochrome c stability toward H_2O_2, in comparison with irradiated control tumors. (auth)

52203 APPLICATION OF THE ELECTRON SPIN RESONANCE TECHNIQUE FOR QUANTITATIVE EVALUATION OF THE RESORPTION RATE OF IRRADIATED BONE GRAFTS. Ostrowski, K.; Dziedzic-Goclawska, A.; Stachowicz, W.; (and others). (Inst. of Nuclear Research, Warsaw. Medical Univ., Debrecen, Hungary). Calcified Tissue Res.; 7: No. 1, 58-66 (1971).

The electron spin resonance (ESR) technique was applied to the investigation of the resorption and creeping substitution of radiosterilized (3.3 Mrads dose) bone grafts in rabbits and dogs. The stable ESR signal arising from the radioinduced structural defect in bone mineral was used as a biological label. The spin concentration and the total number of paramagnetic centers were measured before and after grafting. The gradual decrement of spin concentration as well as that of total number of paramagnetic centers was observed at various time intervals after implantation. On the basis of the unusual stability and lack of chemical reaction of the paramagnetic centers involved, it was concluded that the decrease of the observed ESR signal intensities indicates progressive resorption and substitution. It seems that the proposed method can be useful for research on mineralized tissues. (auth)

52204 α-AMIDRAZONIUM THIOSULFATES AS POTENTIAL ANTIRADIATION AGENTS. Fridinger, Tomas L.; Robertson, Jerry E. (Minnesota Mining and Mfg. Co., St. Paul). J. Med. Chem.; 12: No. 6, 1114-15(Nov. 1969).

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The synthesis of the α-amidrazonium thiosulfates is described. The drugs were administered intraperitoneally to mice and the radioprotective action was evaluated from the 30-day survival percentage following lethal irradiation. (F.M.M.)

52205 PROCEEDINGS OF THE THIRD INTERNATIONAL CONGRESS OF THE TRANSPLANTATION SOCIETY, THE HAGUE, NETHERLANDS, SEPTEMBER 7–11, 1970. Rapaport, Felix T. (ed.). Transplant. Proc.; 3: No. 1, 1-978(Mar 1971). (CONF-700962).

Separate abstracts were prepared for 5 of the 236 papers included in the proceedings. The remaining 231 contain information on transplantation antigens, tissue and organ transplantation and preservation, transplantation biology, immunosuppression, and fundamental transplantation immunology. (E.E.H.)

For abstracts of individual papers see: 52206–52209 and 52236.

52206 CELLULAR INTERACTION BETWEEN THYMOCYTES AND TRANSPLANTED MARROW STEM CELLS. Goodman, Joan Wright (Oak Ridge National Lab., Tenn.). Transplant. Proc.; 3: No. 1, 430-3(Mar 1971).

From third international congress of the Transplantation Society; The Hague, Netherlands (7 Sep 1970). See CONF-700962.

Experiments were conducted to determine why heavily irradiated thymocytes that appear to be microscopically intact at the time of injection fail to improve marrow growth. Thymocytes, labeled with ^{51}Cr and exposed to 10,000 R x rays were injected into lethally irradiated mice. There did not appear to be any difference between localization of irradiated or non-irradiated thymocytes in the organs and tissues of the recipients; however, the irradiated cells did not augment hematopoiesis. Thymic cells exposed to 900 R in vivo that were unable to proliferate were injected into irradiated and nonirradiated recipients. They proved to be as effective as nonirradiated cells in improving marrow growth. The results indicated that thymocytes do not have to divide in order to be effective. (E.E.H.)

52207 DELAYED RECOVERY FROM ACUTE TUBULAR NECROSIS FOLLOWING RADIATION. Meakins, Jonathan L.; Smith, Edwin J.; Aron, Bernard S.; Alexander, J. Wesley (Univ. of Cincinnati). Transplant. Proc.; 3: No. 1, 494-6(Mar 1971).

From third international congress of the Transplantation Society; The Hague, Netherlands (7 Sep 1970). See CONF-700962.

A study was made to determine whether radiation in clinically applicable doses would alter functional recovery of the transplanted kidney with acute tubular necrosis. Nephrectomy was performed on 28 adult female dogs. The kidneys were kept ischemic at 39°C for two hrs. Blood flow was reestablished by reimplantation of the kidney. Twenty dogs received a total of 600 rads of γ radiation to the transplanted kidney. The results showed delayed functional recovery in irradiated kidneys in comparison to nonirradiated kidneys. It is suggested that local radiation should not be used routinely without clinical or laboratory evidence of rejection and should be used judiciously in the treatment of established rejection. (E.E.H.)

52208 PROLONGATION OF RAT HEART ALLOGRAFTS BY DONOR PRETREATMENT WITH IMMUNOSUPPRESSIVE AGENTS. Freeman, J. S.; Chamberlain, E. C.; Reemtsma, K.; Steinmuller, D. (Univ. of Utah, Salt Lake City). Transplant. Proc.; 3: No. 1, 580-2(Mar 1971).

From third international congress of the Transplantation Society; The Hague, Netherlands (7 Sep 1970). See CONF-700962.

Donors of rat heart allografts were treated with x radiation, cyclophosphamide, or antilymphocyte serum. Hearts were irradiated either in situ or by whole-body irradiation. The median survival time (MST) for the controls was 2 to 8 days. In contrast, 16 grafts from whole-body irradiated donors had an MST of 19.7 days with 4 grafts surviving over 30 days. The locally irradiated grafts had an MST of 12.5 and 11 shielded grafts had an MST of 16.0 days. These results suggest that prolongation achieved with whole-body irradiation was a systemic effect. Grafts from 11 donors given a single intraperitoneal injection of cyclophosphamide had an MST of 18.0 with no grafts surviving less than 16 days and two surviving more than 30 days. Heart grafts from donors receiving 0.5 ml of rabbit antirat lymphocyte serum before grafting had a survival time of 17.8 days with 3 grafts surviving 26 to 30 days. Nine grafts from donors pretreated with normal rabbit serum showed no prolongation. (E.E.H.)

52209 PROLONGED RENAL ALLOGRAFT SURVIVAL: EXTRACORPOREAL IRRADIATION OF BLOOD. Chanana, A. D.; Cronkite, E. P.; Joel, D. D.; Stevens, J. B. (Brookhaven National Lab., Upton, N. Y.). Transplant. Proc.; 3: No. 1, 838-40(Mar 1971).

From third international congress of the Transplantation Society; The Hague, Netherlands (7 Sep 1970). See CONF-700962.

Studies were undertaken to evaluate extracorporeal irradiation of blood (ECIB) in renal transplants and to develop the most efficient schedule of ECIB in goats for application to man. Adult female goats were given pretransplant ECIB for 6 to 14 days with 3 to 10 blood volumes irradiation per day with γ radiation at a dose of 260 to 400 rads. Mean survival time following renal transplantation was 17.6 days in comparison to a mean survival time of 16.9 days in control recipients. A second ECIB schedule was devised in which pretransplant ECIB was carried out in 4 to 8 days with 11 to 71 blood volumes irradiated per day at a transit dose of 44 to 55 rads. The recipient survival ranged from 21 to 59 days with a mean survival of 33.8 days. The results indicate that there is a need to evaluate alternative schedules despite the encouraging results of currently used schedules of ECIB in human renal transplantation. (E.E.H.)

52210 EFFECTS OF RADIATION DAMAGE ON ZINC METABOLISM. Bell, M. C.; Sasser, L. B. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). pp 43-9 of Mineral Studies with Isotopes in Domestic Animals. Vienna; International Atomic Energy Agency (1971).

From Panel on mineral studies with isotopes in domestic animals; Vienna, Austria (28 Sep 1970). See STI/PUB-293; CONF-700966.

Whole-body exposure to gamma and neutron radiation alters mineral metabolism for a few days after irradiation. Pigs exposed simultaneously to 268 rads of fission spectrum neutrons and 37 rads of gamma radiation absorbed less ^{65}Zn than control pigs only when they were fed low Zn rations. Irradiating the gastro-intestinal tract of sheep with ^{90}Y-labelled sand at levels to cause digestive disturbances significantly increased the in vitro erythrocytic uptake of ^{65}Zn. This effect was evident within one week after exposure and lasted over 6 weeks. Beta radiation applied to the dorsa of sheep (12% of the body surface) significantly increased the in vitro erythrocytic ^{65}Zn uptake beginning 8 weeks after exposure and this increase persisted for one year in some sheep. The stable Zn content of plasma was slightly reduced in some of these sheep but Zn levels in erythrocytes were not altered. Whole-body exposure to gamma radiation of 240 R from ^{60}Co at 1 R/min was without effect on stable Zn in blood and had no effect on in vitro erythrocytic ^{65}Zn uptake. Research is still in progress on the effects of beta and gamma radiation on mineral metabolism in cattle. (auth)

52211 BLASTOMOGENIC EFFECT OF IONIZING RADIATION ON DOGS. Shikhodyrov, V. V.; Lebedeva, G. A.; Lebedev, B. I.; Evseeva, N. K. Vop. Onkol.; 17: No. 5, 55-60(1971). (In Russian).

The development of tumors in 33 dogs in late terms after injection of polonium or γ-neutron irradiation was studied. There was noted a considerable rate of incidence of neoplasms in irradiated animals, especially in organs where radiation energy was maximum. In later terms, tumors of the internal secretion glands rather frequently develop. Their development occurs on the background of persistent structural disturbances. An analysis of some indices revealed a relatively low capacity of radiation tumors to produce metastases and multiple incidence in different organs. (auth)

52212 THYROID ACTIVITY IN ANIMALS EXPOSED TO REITERATED SMALL DOSES OF IONIZING RADIATION. Denisiewicz, Roscislaw; Maziarz, Zbigniew; Dworakowski, Mieczyslaw. Acta Physiol. Pol.; 22: No. 3, 351-60(May-Jun 1971). (In Polish).

Thyroid activity was investigated in 82 rats exposed to small x-ray doses. The animals were distributed into five groups that were repeatedly irradiated by doses of 0.150 to 30 R. The assessment of the function of the thyroid gland was carried out by means of determining the thyroid uptake and PBI in serum. The investigations showed a reduction of the accumulation of ^{131}I in the thyroid gland and an increase of PBI in the serum of the animals investigated according to the dose of radiation absorbed. The results of investigations obtained suggested that the disorders of the thyroid gland are conditioned by irradiation disorders in the functioning of the higher neurosecretion centres. (auth)

52213 COMPARISON OF AUTOLOGOUS MARROW INJECTION TO SHIELDING IN LETHAL IRRADIATION OF THE MOUSE. Carsten, A. L.; Cronkite, E. P. (Brookhaven National Lab., Upton, N. Y.). Proc. Soc. Exp. Biol. Med.; 137: No. 3, 948-51 (Jul 1971).

Four groups of mice were given 700 to 1300 rads of whole-body x radiation. In the first group the right leg was shielded during irradiation, then amputated, the marrow cells harvested from the entire leg and injected into the tail vein. In the second group the right leg was shielded during irradiation, then immediately following irradiation the left leg was amputated. This allowed for migration of shielded elements from the right leg while submitting the animal to surgical stress. In the third group the right leg was shielded during irradiation and no surgery was performed. In the fourth group the animals were irradiated without any shielding. A table is presented to show numbers of animals surviving in each group. Results indicate that the reinjection of autologous marrow from shielded portions of animals results in some degree of protection as compared to total-body irradiated animals. However, when compared to the shielded animals without reinjection there appears to be no advantage, and at higher dose levels there is evidence of a deleterious effect. (H.L.W.)

52214 EPILATION AND HAIR GREYING IN HAMSTERS FOLLOWING ONE SINGLE APPLICATION OF BETA RAYS. **Garcia, Humberto; Shubik, Philippe (Eppley Inst. for Research in Cancer, Omaha). J. Invest. Dermatol.; 57: No. 2, 94-9(Aug 1971).**

Syrian golden and white hamsters were exposed to a single application of beta rays from a ^{85}Kr source in doses of 2,000, 4,000 and 10,000 rads. Permanent epilation was observed in Golden hamsters receiving the highest dose, permanent greying of hair was observed in lower doses. In white hamsters, permanent epilation occurred at lower doses than those for golden hamsters. Intense atrophy of the epidermis was observed histologically in animal's skin exposed to highest doses. A relatively higher mortality rate was observed in animals receiving higher doses of radiation. No spreading of the hair-greying effect of beta rays was observed in this experiment. (auth)

52215 RADIOSENSITIVITY OF IN VIVO MOUSE BONE MARROW CELLS. **Kagan, A. R.; Hamilton, M. A.; Bryant, T. L. (National Cancer Inst., Bethesda, Md. Cedars-Sinai Medical Center, Los Angeles). Radiol. Clin. Biol.; 40: No. 2, 142-9 (1971).**

Radiosensitivity of in vivo mouse bone marrow cells in DBA and CDBA mice is presented using the animal rescue method. The number of donor cells required to keep 50% of the lethally irradiated recipient mice alive was determined for 0 to 400 rad. $LD_{50's}$ were observed using different time dose fractionation regimes. It is concluded that the amount of recovery depends on the technique and the method used. (auth)

52216 INSTANTANEOUS REACTIONS OF GUINEA-PIG VAS DEFERENS PREPARATION TO X IRRADIATION. GENERAL RADIOBIOLOGICAL STUDIES. **Michailov, M. Ch. (Gesellschaft fuer Strahlen- und Umweltforschung mbH., Munich). Biophysik; 7: 276-82(1971).**

In the mechanical-inactive guinea pig vas deferens x rays (25 kV) at threshold doses of about 100 kR initiated phasic activity and an immediate increase in tone. After addition of acetylcholine, noradrenaline, or adrenaline to the rinsing solution a slight contractile activity of vas deferens appeared and the preparation reacted to x irradiation at a threshold dose of 3 to 5 kR (dose-rate 20 kR/min) with increased phasic contractions and with a dose and dose-rate dependent tonic contraction. After repeated irradiation a sensitization was observed. X rays produced tonic contractions of the vas deferens preparation up to a total dose of about 200 kR (fractionated irradiation). An irreversible contraction of the vas appeared after continuous exposure to x-ray doses larger than 500 kR (dose rate 20 kR/min). (auth)

52217 DOSE AND TIME DEPENDENCE OF RADIATION-INDUCED CHROMOSOME ABERRATIONS IN RAT EMBRYOS. I. IRRADIATION DURING ORGAN GENESIS. **Eicke, Jutta; Hug, O. (Univ., Munich). Gesellschaft fuer Strahlen- und Umweltforschung, Neuherberg, Ger.). Biophysik; 7: 322-41 (1971). (In German).**

Eighty pregnant female rats (Wistar) were exposed to whole-body irradiation with doses from 10 to 400 R of x rays. 0 to 96 hr later primary cultures of embryonic cells were made and investigated for chromosome aberrations. Immediately after irradiation with all doses the number of cells with chromosome aberrations was increased as compared to untreated animals serving for control. The average breakage number per cell rose from the control value of 0.03 to 4.88 after exposure to 400 R. When the intervals between irradiation and killing of the animals were elongated the number of chromosome aberrations dropped drastically during the first 12 hr. Later on, the decrease was slower. 96 hr after irradiation within all doses the control values were nearly reached. Type and time relationship of radioinduced aberrations is described and compared to chromosome aberrations in highly proliferating tissues of adult mammals and in lymphocytes of man. The mechanisms leading to the rapid reduction of chromosomally damaged cells, especially in highly proliferating tissues are discussed. (auth)

52218 REGENERATION OF PROLIFERATIVE ACTIVITY IN THE PROGENY OF MURINE LYMPHOMA CELLS L5178Y IRRADIATED WITH X RAYS. **Beer, J. Z.; Ziemba-Zak, B.; Rosiek, O.; (and others) (Inst. of Nuclear Research, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Biol.; 18: No. 9, 581-4(1970).**

Studies were made on the mechanisms by which cultures of murine lymphoma cells L5178Y recover from radioinduced growth inhibition. Cell cultures were irradiated with 200 kV x rays at a dose rate of 5.74 rad/sec and cloned in agar supplemented medium The growth kinetics of the sublines obtained by cloning of control non-irradiated cultures was compared with that of the cultures irradiated with doses of 200 and 300 rads. After 200 rads, one-half of the sublines originating from single cells had prolonged doubling times but reached a normal rate 20 to 22 days following irradiation. After 300 rads, the proportion of sublines with reduced growth rates was somewhat lower but the differences between control growth rates and the sublines persisted for 65 days. These observations indicate the existence of mechanisms capable of repairing some types of radioinduced lesions that are transferrable to descendant generations. It was found that these mechanisms can operate even at late stages of irradiated cell population development. (E.E.H.)

52219 CHARACTERISTICS OF THE ACTION OF FAST NEUTRONS ON THE NERVOUS SYSTEM. **Panov, A. G.; Ulitovskaya, I. I.; Ulitovskii, D. A. Zh. Nevropatol. Psikhiat.; 70: No. 11, 1601-5(1970). (In Russian).**

Rats were exposed to radiation from a VVR-M reactor. Neutrons constituted 92% of the radiation and doses of 150, 200, and 300 rad were given. A histological study revealed a degeneration of cells and filaments in the nervous system. Vascular changes and changes in the glia were noted. The changes compared to those following gamma radiation were much more severe; there were more localized symptoms and gastrointestinal symptoms were more pronounced. According to morphological indices the relative biological effectiveness of neutrons was 3 to 10. Analyses of effects at molecular, cellular, tissue, and organ levels revealed distinct mechanisms of action. (auth)

52220 EFFECT OF FRACTIONATED IRRADIATION ON HEMATOPOIESIS OF FASTED RATS. **Ninkov, V.; Dragic, M.; Hajdukovic, S. Haematol. Lat. (Milan); 13: 125-33(Apr-Jun 1970).**

The effect of fractionated irradiation (3 × 326 R) on hematopoiesis of fasted rats has been investigated. Intervals between fractions were four days. Control groups of animals were exposed to a single dose of 706 R. The changes were followed in peripheral blood and bone marrow. Results have shown that after fractionated irradiation, a temporary inhibition of mitotic activity of erythroid cells occurs. After this inhibition a rapid regeneration occurs until values are above normal. Inhibitory effects on myelopoiesis were also observed. (auth)

52221 EARLY EFFECT OF RADIATION ON STOMACH MUCOSA. **Hirose, Fumio (Hiroshima Univ.). Nippon Gan Chiryo Gakkaishi; 5: No. 1, 56-8(Mar 1970). (In Japanese).**

A large dose (2000 rads) of x rays was administered to a mouse stomach followed by an intravenous injection of ^{3}H-thymidine and the mucosa was examined for radiation injuries. Among the changes found were marked atrophy of the mucosa, excessive ulcer formation, epithelialization of glandular tissues, and protracted atypical regeneration. Proliferation of atypical glandular tissues was noted 20 days after irradiation. Decreased incorporation of ^{3}H-thymidine and inhibition of mitosis were observed one hour after irradiation in mucosal cells; dilatation and destruction of nuclei increased with time and mucosal atrophy was observed after 12 hours. In slightly damaged mucosa regeneration and incorporation of ^{3}H-thymidine began two days after irradiation; in badly damaged mucosa incorporation of ^{3}H-thymidine began after five days and regeneration was markedly delayed. Regeneration of mucosa was chiefly brought about through proliferation of mucosal cells. It appeared that chief cells proliferated during severe mucosal damage. (Japan)

52222 CHANGES IN THE RAT BLOOD SERUM PROTEINS AFTER ULTRAVIOLET IRRADIATION OF THE ORAL MUCOUS MEMBRANE. **Tyupenko, G. I. Stomatologiya; 49: 14-16(Nov-Dec 1970). (In Russian).**

An experimental investigation was carried out on 128 albino rats by means of paper electrophoresis. Changes in rat blood serum protein fractions consist mainly of an increase of gamma- and beta-globulins. This indicates that ultraviolet irradiation of

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the oral mucous membrane augments the immunobiological activity of the organism. (auth)

52223 EFFECTS OF IONIZING IRRADIATION ON THE PERIODONTIUM IN EXPERIMENTAL RATS. Krzywicki, J.; Klimek, H. (Medical Academy, Warsaw). Deut. Zahnaertztl. Z.; 26: No. 4, 494-502(Apr 1971). (In German).

Investigations were made with regard to the question as to whether radio-lesions are due to the direct exposure of the periodontium or whether they are the consequence of irradiation of the total organism. For this purpose test animals were irradiated, some of them exclusively at the head and some at the body with the head protected against the x-rays. The macroscopic and histological findings are described and it is shown that primarily the former treatment is of significance with regard to the pathogenesis. (auth)

52224 POSTNATAL DEVELOPMENT AND CHROMOSOME ABERRATIONS IN RATS IRRADIATED IN UTERO WITH GAMMA RAYS. Baev, I.; Bairakova, A. Akush. Ginekol.; 9: 281-8 (1970). (In Bulgarian).

Pregnant rats were irradiated with 50 and 100 R gamma rays. The litters delivered of them were followed-up in respect to mortality, retarded growth, nanism, weight of the male gonads, anomalies of the fingers and chromosome aberrations in the bone-marrow cells. Smaller dose of 50 R caused only retarded growth and rudimentary testes but irradiation with 100 R caused reduced mean number of litters in a single birth and high postpartum mortality (26% against 5% of the controls). Finger anomalies were observed as a result of irradiation with 50 and 100 R. There were also persisting chromosome anomalies: aneuploidy, chromatid and chromosome disintegrations with preserved acentric fragments, and dicentrics. (auth)

52225 ELECTRON MICROSCOPY OF X-RAY HIGH DOSE EFFECTS ON THYMUS CORTEX. Alexandrova, S. E.; Gulaev, V. A. (Research Inst. of Medical Radiology, Obninsk, USSR). Stud. Biophys.; 26: No. 2, 117-23(1971).

The thymuses of locally x-irradiated Wistar rats were studied electron-microscopically 5 and 24 hours after irradiation. In the cortical zone of the thymuses exposed to 5 and 25 kR of x-irradiation some nuclei were found that contained irreversibly coagulated chromatin. These nuclei, termed pseudonormal, were thought to be responsible for the so-called paradoxical effect of high dose action on thymus cortex. (auth)

52226 INDUCTION OF LEUKEMIA AND LIFE SHORTENING IN MICE BY CONTINUOUS LOW-LEVEL EXTERNAL GAMMA RADIATION. Warren, Shields; Gates, Olive (New England Deaconess Hospital, Boston). Contract AT(30-1)-3777. Radiat. Res.; 47: No. 2, 480-90(Aug 1971).

Continuous external gamma radiation throughout life at the rate of 0.062 rad/day failed to induce leukemia in A/Jax mice, but did in 55% of RAP mice. Sixty percent were lymphatic, 23% myelogenous, and 17% of other types of leukemia. In RAP mice there was no significant shift in frequency of leukemia in each of five successive generations. The experimental mice were compared with mice irradiated from an internal radiation source and also controls. The incidence of leukemia in control mice was 7%. The high incidence of leukemia in this irradiated population cannot be explained, but the probability is strong that the population evolved from highly leukemia-susceptible mice. (auth)

52227 EFFECT OF WHOLE-BODY X-IRRADIATION ON PULMONARY BACTERICIDAL FUNCTION. Hahn, F. F.; Goldstein, E.; Dungworth, D. L. (Univ. of California, Davis). Radiat. Res.; 47: No. 2, 461-71(Aug 1971).

The mechanisms responsible for the enhanced pulmonary susceptibility to infection following x-irradiation are poorly understood. Since the intrinsic antibacterial mechanisms normally keep the lungs bacteria free, quantitative assessment was made in mice of the impact of sublethal x-irradiation on killing and removal of inhaled bacteria. Mice were irradiated with 500 R and exposed to aerosols of ^{32}P-labeled Staphylococcus aureus at 3, 10, 14, 21, and 31 days postirradiation. Measurements of pulmonary bacterial and radioisotope concentrations 0 and 4 hours after inhalation allowed calculation of the rates of both physical removal and intrinsic pulmonary bacterial killing. Electron microscopic studies of macrophages washed from the lungs, histologic studies of lung sections, and routine hemograms were also performed. Pulmonary bactericidal function was slightly decreased on day 14 and markedly decreased on day 21 ($P < 0.01$). Bactericidal function was not impaired 3, 10, and 31 days after irradiation. Physical removal of bacteria was not affected by x-irradiation. Peripheral blood studies showed a leukopenia on days 3 and 10 and normal values at later time periods. Neither ultrastructural nor histological abnormalities were found. According to these data, x-irradiation transiently depresses intrinsic pulmonary bactericidal activity at 2–3 weeks after exposure and accounts at least in part for the enhanced susceptibility to respiratory infection. (auth)

52228 ESTIMATION OF THE RBE OF STOPPED PIONS FROM OBSERVATIONS OF SPERMATOGONIA SURVIVAL IN MICE. Baarli, J. (CERN, Geneva); Bianchi, M.; Sullivan, A. H.; Quintiliani, M. Int. J. Radiat. Biol.; 19: No. 6, 537-46(1971).

The survival of spermatogonia of type B in mice after exposure to negative and positive pions is presented. It is found that the survival curve in the case of negative pions has an inverse shoulder and in the case of positive pions the best fit seems to be a straight line. The observed survival curves were compared to provide information about the radiobiological significance of the negative pion nuclear interactions. Discussions of the results obtained show that one cannot exclude the possibility that the biological system used might behave as a mixed population in the case of negative pions as compared with x rays. (auth)

52229 SURVIVAL OF MOUSE-SKIN EPITHELIAL CELLS AFTER HEAVY PARTICLE IRRADIATION. Leith, J. T.; Schilling, W. A.; Welch, G. P. Int. J. Radiat. Biol.; 19: No. 6, 603-9(1971).

The technique involved irradiation of the epidermis and then of the surrounding tissue to prevent any cell regrowth into the treated area. Individual animals were positioned to expose an area on the ventral surface, the beam being homogenous over the area irradiated. The helium-beam and mylar absorbers used for helium ion exposures are described, dose rates being about 3 krads per minute. Lithium and carbon-ion experiments were also carried out, average dose rate being 5000 rads per minute. The mice were observed until the response was complete; ulcerations and clones were observable from about day 10 onwards. Results are tabulated, survival values/cm^2 for the single 1250 rad doses for animals irradiated with lithium and carbon-ions being included. The heavy ions appear to have greater effect than either 29kVp or 250kV x rays. Tentative doses for lithium and carbon ions were also found. It appears that the shallower the penetration, the less the effect, irrespective of absolute dose and LET. Tests were carried out to determine the dependence of cell survival/cm^2 on penetration depth and results are tabulated. Damage to the dermal supportive bed of the skin seems influential in epidermal cell survival after irradiation. (UK)

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Refer also to abstracts 52021, 52022, 52063, 52067, 52085, 52089, 52096, 52118, 52155, 52163, 52165, 52168, and 52172.

52230 (A/CONF.49/P–535) EVALUATION OF THE LONG-TERM EFFECTS OF HIGH BACKGROUND RADIATION ON SELECTED POPULATION GROUPS OF THE KERALA COAST. Gopal-Ayengar, A. R.; Sundaram, K.; Mistry, K. B.; Sunta, C. M.; (and others) (Bhabha Atomic Research Centre, Bombay (India)). May 1971. 31p. (CONF-710901–298). Dep. NTIS (U. S. Sales Only)

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Investigations on human populations which are subjected to high levels of natural background radiation offer possibilities for evaluating the long-term effects of chronic radiation exposure in man. Monazite bearing high radiation areas exist along the south-west coast of India. Here a strip of about 55 kilometers has definable geographical landmarks, includes the most concentrated distribution of monazite, and supports a high density of population. Demographic data, including detailed fertility history of over 13,500 households (about 67,000 individuals), residing in this region were collected. Dosimetric survey of 20 percent of this population using calcium fluoride thermoluminescent dosimeters was completed. Processing of a representative sample of the dosimetric data revealed that about 20,000 individuals in this region are likely to be receiving radiation dose between five to 10 times normal background. These data are being analyzed to yield information on the genetic and somatic effects of chronic low-dose irradiation on man. (auth)

52231 (JPRS-53801) SPACE BIOLOGY AND MEDICINE, VOL. 5, NO. 3, 1971. Translation of Kosm. Biol. Med.; 5: No. 3, 3-92(1971). 150p. NTIS.

Separate abstracts were prepared for three articles in this English translation of the Russian publication. An additional 20 articles are included on various aspects of space biology and medicine. (H.L.W.)

For abstracts of individual papers see: 51991, 52021, and 52254.

52232 LATE DAMAGES AFTER RADIATION THERAPY OF MALIGNANT TUMORS IN CHILDHOOD. I. LATE CONSEQUENCES FOLLOWING IRRADIATION OF KIDNEY TUMORS. **Strietzel, M.; Eberhardt, H.-J. (Carl Gustav Carus Medizinische Akademie, Dresden). Radiobiol.-Radiother.; 11: No. 3, 251-63(1970). (In German).**

Three patients are reported who were examined from seven up to 13 years after radiation therapy. The irradiation was performed after nephroectomy for a malignant renal tumor at the age of eight months, one year, and seven years. Atropic and indurative changes of the irradiated soft parts, unilateral disturbances of growth, and deformities of the spinal column and the crest of ilium, with the development of sclerosis without essential functional impairment of the spinal column were found. The development of radioinduced late damages should be counteracted by orthopedic treatment. (auth)

52233 CATAMNESTIC EXAMINATIONS OF THE URINARY TRACT OF PATIENTS AFTER CONVENTIONAL AND TELECOBALT IRRADIATION. **Taubert, W.; Prager, W.; Tietze, D. (Karl-Marx-Univ., Leipzig). Radiobiol.-Radiother.; 11: No. 5, 601-9(1970). (In German).**

Radiation injuries of the kidneys and urinary tract are described that were observed in 38 patients following post-surgical irradiation for the treatment of testicular neoplasms using deep x ray therapy and telecobalt γ radiation. The injuries included hematuria, proteinuria, papillary necrosis, ureteral stenosis, muscular contractions, and hypertension. The necessity for careful planning of the irradiation schedule and intensive after-care of patients to avoid complications is stressed. (C.H.)

52234 STUDIES ON THE BEHAVIOR OF LEUKOCYTE VOLUME FOLLOWING WHOLE-BODY AND PARTIAL-BODY IRRADIATION. **Neumeister, K.; Hagen, R. (Karl-Marx-Univ., Leipzig). Radiobiol.-Radiother.; 11: No. 4, 435-40(1970). (In German).**

Results are reported from studies on the effects of whole-body x radiation on the leukocyte count in peripheral blood samples of swine and the effects of therapeutic irradiation of neoplasms using fractionated doses of x radiation on the leukocyte count in man. The results were limited because of the wide variations in normal leukocyte volume and the possibility of errors. It was concluded that the leukocyte count is not an accurate biological dosimeter. (auth)

52235 EVALUATION OF HEALTH HAZARD TO THE PUBLIC ASSOCIATED WITH NUCLEAR PLANT OPERATIONS. **Stannard, J. Newell (Univ. of Rochester, N. Y.). pp XII.1-16 of Nuclear Power and the Environment. Madison, Wis.; Univ. of Wisconsin (1970).**

From Conference on nuclear power and the environment; Madison, Wis. (3 Apr 1970). See CONF-700415.

The biological and medical effects of radiation as they relate to the public health hazards of nuclear power operations are discussed. The discussion is presented in three sections including: the biological basis for maximum permissible exposures; estimates of the quantitative effects of exposures in the environment of a nuclear reactor; and a brief comparison of these effects with other factors impinging on the health of the public. (E.R.B.)

52236 EXTRACORPOREAL IRRADIATION OF THE BLOOD: LYMPHOCYTE TRANSFORMATION TESTS AND CLINICAL RESULTS AFTER RENAL TRANSPLANTATION. **Weeke, Eva; Soerensen, Soeren Freisleben (Rigshospitalet, Copenhagen). Transplant. Proc.; 3: No. 1, 387-90(Mar 1971).**

From third international congress of the Transplantation Society; The Hague, Netherlands (7 Sep 1970). See CONF-700962.

The lymphocyte responsiveness before and after extracorporeal γ irradiation of the blood (ECIB) was investigated by means of the lymphocyte transformation tests. The response to phytohemagglutinin was unchanged while the response to purified tuberculin and allogeneic cells was reduced per unit number of lymphocytes after ECIB. The results indicate that the fraction of thymic-derived cells left in the peripheral blood after ECIB was unchanged, but that the immunological function of these cells was impaired. The clinical results of renal transplantation in 16 patients who received ECIB before and after grafting of necro-kidneys were compared to the results in a control group of 29 patients. A significant reduction in rejection episodes within the first 6 weeks after transplantation was demonstrated. (auth)

52237 EARLY MANIFESTATION OF ANAPLASTIC THYROID CANCER AFTER RADIOIODINE TREATMENT FOR TOXIC NODULAR GOITRE. **Nemec, J.; Niederle, B.; Cenkova, V.; Vana, S.; Zeman, V. (Charles Univ., Prague). Neoplasma; 18: No. 3, 325-33(1971).**

A case of toxic nodular goitre treated by radioiodine is described in detail. Without any suspicion of possible thyroid malignancy, 29.3 mCi of ^{131}I was administered delivering a dose of 15,000 rads to the thyroid. Three weeks after the administration, a rapid growth of preexisting functionally active nodule in the right lobe was observed. Surgical intervention failed to save the patient and he died 11 days later from rapid progression with multiple lung metastases and intravascular propagation of cancer into pulmonary arteries. Anaplastic solid thyroid cancer with spurious follicular differentiation was found. The relationship between radiation exposure and development of thyroid cancer is discussed. It seems most probable that occult thyroid cancer was already present before the radioiodine administration, and dramatic change in its biological properties could be attributed to radioiodine in spite of the extremely short lag interval. (auth)

52238 LOCALIZED APLASIA IN IRRADIATED VERTEBRAL BONE MARROW. A FREQUENTLY OVERLOOKED GROSS OBSERVATION. **Schantz, Arthur; Schiller, Alan L.; Kadish, Sidney P. (Harvard Medical School, Boston. Massachusetts General Hospital, Boston). Arch. Pathol.; 92: No. 3, 187-90 (Sep 1971).**

Localized aplasia of vertebral body bone marrow secondary to therapeutic doses of ionizing radiation was found in eight cases. The gross feature is a sharply circumscribed glistening yellow focus in a portion of the normally red-brown bone marrow. Bone trabeculae are normal in pattern and number. Microscopically, fatty replacement of hematopoietic marrow without bone necrosis can be seen. This lesion is not discernible with diagnostic roentgenograms. It should be distinguished grossly from metastatic tumor or other osseous lesions. This finding illustrates the importance of routine examination of the vertebral column at postmortem examination and alerts the pathologist to the exact portal of radiation therapy previously used. (auth)

52239 FETAL TOLERANCE TO ROENTGEN RAYS. CASE REPORT: BIRTH OF AN UNSUSPICIOUS CHILD AFTER X-RAY EXPOSURE IN UTERO DURING THE FIRST THREE MONTHS OF GESTATION. **Buchheim, C. E. (Univ., Basel). Radiol. Clin. Biol.; 40: No. 1, 22-8(1971). (In German).**

In a woman of 39, a carcinoma of the breast, St. II., was found accidentally after a gall-bladder operation. The tumor was operated and routine-postoperatively irradiated. It was then found that the patient was already pregnant. The foetus, during the first 3 months of pregnancy, had received a dose of approx. 20 to 40 rads. After a slightly prolonged pregnancy a male child was born who did not show any obvious abnormality. He will however be closely followed up. This experience shows that in women, who have not yet reached the menopause, prior to any radiotherapy a pregnancy test and/or contraceptional measures are indicated. (auth)

52240 INTERSTITIAL RADIUM TREATMENT OF TONGUE CARCINOMA IN PATIENTS OF THE ONCOLOGICAL INSTITUTE IN WARSAW. **Danczak, Z. Nowotwory; 21: No. 2, 149-54(1971). (In Polish).**

The results of treatment of 115 patients with tongue carcinoma are presented. Treatment was conducted by means of the local interstitial application of radium. Recidives in the primary focus were observed in 14% and post-irradiation necroses in 40% of the cases. In 56 patients, the lymph nodes of the neck were subjected to surgery by the method of Crile; in 52% of these cases metastases were histologically confirmed. The metastases after operation were observed in 52%. Five year survival without neoplastic symptoms was found in 45.2% of cases without neoplastic symptoms (I^0– 77%, II^0– 58%, III^0– 37%, IV^0– 0%). 10 year observation revealed 37.5% of recoveries. The method is accompanied by a high probability of incidences of postirradiation necroses (40%). (auth)

52241 EFFECT OF IRRADIATION THERAPY ON CIRCULATING BLOOD IN PATIENTS WITH LUNG CARCINOMA. **Marczynska, A.; Kujawska, J.; Adamczyk, B.; Pawlicki, M. Nowotwory; 21: No. 2, 107-12(1971). (In Polish).**

In a group of 17 patients suffering from lung cancer, the determination of blood volume using the dye-plasma-hematocrit method was carried out, before and after radiotherapy. The loss of blood was observed in 76 of the patients; in 47% it was of higher degree. There was marked predominance of the loss of red cell mass in relation to the loss of plasma. (auth)

52242 OSTEOMYELITIS AND OSTEORADIONECROSIS OF THE JAWS. **Titterington, W. P. (Armed Forces Inst. of**

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Pathology, Washington, D. C.). J. Oral Med.; 26: No. 1, 7-16 (Jan-Mar 1971).

Clinical manifestations, etiology, radiography, treatment, and prognosis of the various types of osteomyelitis are discussed. In addition, discussions are presented of clinical manifestations of osteomyelitis of children and young adults, osteomyelitis of the newborn and infants, and osteomyelitis secondary to radiation. Pathological and histological changes in osteoradionecrosis are described and recommendations for treatment and prevention are given. Pathological changes in the oral mucosa membranes and salivary glands following radiation are described and the development of radiation caries as an associated effect related to diminution of salivary gland secretions is discussed. The importance of dosimetry is emphasized and maximum radiation tolerance doses are discussed. (H.L.W.)

52243 LATE IRRADIATION DAMAGES IN THE RETROMANDIBULAR REGION AFTER CAROTID ANGIOGRAPHY AND AFTER SIALOGRAPHY WITH THOROTRAST. Manzke, E. (Katharinenhospitals, Stuttgart). Z. Laryngol., Rhinol., Otol.; 50: 33-40 (Jan 1971). (In German).

The late effects of radiation after the injection of thorotrast around the carotid are described in a man aged 55 and after parotid sialography in a man aged 46 after more than 25 years. The diagnosis was made physically and histologically. A "thorotrastoma" along the carotid artery caused a recurrent nerve paralysis in the last 10 years. The available literature does not mention any cases of thorotrast damage after sialography. The fibrogenic granulomas removed from both patients showed no signs of malignancy. (auth)

52244 UNUSUAL CASE OF RADIATION INJURY OF THE LUNGS. Lyubushin, A. A. Arkh. Patol.; 32: 67-70(1970). (In Russian).

A case of radiation injury of the lung in a 64-year-old patient who was x-irradiated for therapeutic purpose is described. Besides marked morphological changes characteristic of radiation injury of the lungs (radiation pulmonitis), erythrography, never described in literature before, was noted in injured cells of the alveolar epithelium. (auth)

52245 INFLUENCE OF THE DOSE PER FRACTION ON RADIATION DAMAGE TO THE MYELUM. den Hoed-Sijtsema, S.; Kaalen, J. G. A. H.; Crezee, P. (Rotterdamsch Radio-Therapeutisch Instituut, Rotterdam). Radiol. Clin. Biol.; 40: No. 2, 89-99(1971).

The clinical phenomena and differential diagnosis of myelopathy are discussed briefly, the latent period preceding the clinical symptoms in more detail. The latent period must be closely related to the histological changes found after irradiation, but in spite of the many investigations and animal experiments the biological reactions of neural tissue are still poorly understood. The question of whether there is a tolerance dose is an important one. Few animal experiments have been done with fractionated irradiation. The curves constructed on the basis of observations in man are discussed. Although these curves give the lowest doses at which myelopathy developed, they involve many uncertain factors. The results of analysis of the author's material are reviewed. Eleven patients developed myelopathy after irradiation of the thoracic or cervical spinal cord with telecobalt. The latent period averaged 1 year and 5 months. For purposes of comparison, an analysis was made of the irradiation factors for 18 patients with lung cancer treated with the same tumor dose (6,000 rad) in whom no neurological anomalies had developed 2 years after treatment. There was no difference between the two groups (M+ and M−) with respect to total dose and total time, but there was a significant difference with respect to the average fraction size and the number of fractions. For each case, the cumulative fraction sizes were plotted against the number of fractions. If for each group (M+ and M−) the average value of all the cases is taken, the resulting line for the M+ group lies higher than for the M− group. The difference is statistically significant. It is concluded that this analysis indicates that the size of the fraction and the number of fractions are more important factors than the total dose and the total time of exposure. These observations argue for the existence of a tolerance dose. Further study would seem to be indicated. (auth)

52246 BRAIN DAMAGE AFTER X-RAY THERAPY. Evers, W. Th.; Jaspar, H. H. J. (Univ. of Nijmegen, Netherlands). Radiol. Clin. Biol.; 40: No. 2, 125-32(1971).

A case of symmetric, bilateral delayed radionecrosis of the temporal lobes after irradiation by arc-therapy of a pituitary gland tumor is described. Histologically, areas of demyelination, regressive changes in astroglia, vascular changes, and even of complete tissue destruction can be recognized; reactive phenomena (e.g., phagocytosis, proliferation, and demarcation) are absent. Obviously radionecrosis occurs incidentally at a dose that is usually well tolerated. (auth)

52247 DOSE DEPENDENCE OF THE CHROMOSOME ABERRATION RATE IN THOROTRAST PATIENTS. Kemmer, W.; Muth, H.; Tranekjer, F.; Edelmann, L. (Univ. of the Saarland, Homburg). Biophysik; 7: 342-51(1971).

An increasing dose-effect relationship was found between the chromosome aberration rate and the radiation dose in 51 Thorotrast patients. Equations are given for the relationship. The power exponent is less than 1, in contrast to examinations in vitro in which it varies between 1 and 2. It is suggested that some cells damaged by radiation in vivo are eliminated by the body. The large variance of the aberration rate in relation to the radiation dose determined in vivo indicated that the usual method of scoring 100 cells per case is not sufficient to give a statistically significant relationship. It is estimated that at least 500 cells need to be scored in each case. This will be possible when an automatic chromosome analyzer becomes available. (auth)

52248 STUDIES ON LYMPHOCYTES DURING EXTRACORPOREAL IRRADIATION OF THE BLOOD IN PATIENTS WITH ACTIVE CIRRHOSIS. Andersen, Vagn; Bjerrum, Ole; Ranek, Leo (University Hospital, Copenhagen). Scand. J. Haematol.; 7: 471-7(1970).

The lymphocyte concentration in the blood was followed closely in four patients with active cirrhosis who were treated with extracorporeal irradiation of the blood (ECI). A reduction to 25% of the original values was obtained, and three months after treatment the lymphocyte concentration remained below 50% of pretreatment values. This is not significantly different from the results previously obtained in uraemic patients although a much more concentrated treatment schedule was employed in the present patients. This shows that the large majority of the recirculating lymphocytes pass through the blood within 3–4 days. In vitro simulation of blood lymphocytes with phytohaemagglutinin showed that in the three patients studied the response per cell did not change significantly during ECI. However, the initially positive transformation response to tuberculin in vitro changed into a negative one during ECI in all cases, indicating that a selective depletion of the tuberculin-sensitive cells of the blood took place during ECI. (auth)

52249 ASSOCIATION OF LOW SERUM MAGNESIUM CONCENTRATION WITH SEVERITY OF GASTROINTESTINAL SYMPTOMATOLOGY IN THE IRRADIATED PATIENT. Tansy, Martin F.; Nichini, Franco M.; Baker, H. Weldon; Chrzyanowski, John (Temple Univ., Philadelphia). J. Surg. Res.; 11: No. 5, 213-16 (May 1971).

The blood serum concentrations of magnesium and calcium were determined in 24 patients receiving radiation therapy for ovarian carcinoma using atomic absorption spectrophotometry. In all cases, low concentrations of magnesium in the patients' sera were associated with the onset of gastrointestinal symptomatology comparable to that observed in animals. There was no direct correlation between the calcium and the magnesium present in their sera. (auth)

52250 EFFECT OF IONIZING RADIATION ON THE EYESIGHT. Trzcinska-Dabrowska, Zofia (Inst. for Radiobiology and Health Protection, Warsaw). Klin. Oczna; 39: No. 3, 507-11(1969). (In Polish).

The injurious effect of ionizing radiation on eyesight has been known since 1897. The effects are illustrated by presenting the delayed complications resulting from the radiation treatment of carcinoma of the eyelid, reported by S. Levitt et al. Similar observations were made on survivors of the Hiroshima and Nagasaki atomic bombing: radiation affected the eyesight of the victims. Development of cataracts may occur any time from 3 months to 12 years after the exposure; it takes an average of 3 years. The effect of x and γ rays and of neutron flux on the eyes is almost identical. (Review article, 21 references). (TTT)

52251 INJURIOUS EFFECTS OF RADIOTHERAPY IN AGED WOMEN WITH MALIGNANT GENITAL NEOPLASMS. Mannarini, G.; Guindani, A.; Bulfoni, G. (Istituto Nazionale per lo Studio e la Cura dei Tumori, Milan). G. Gerontol.; 18: 315-19(Apr 1970). (In Italian).

Radiological treatment of women at geriatric age for pelvic malignancy was not observed to induce any damage on treated patients. Ninety nine women (age average 71.7) were followed during radiological treatment for cervical carcinoma (72 patients), endometrial carcinoma (12 patients), and vaginal carcinoma (15 patients). Radiological treatment consisted of intracavitary radium (total dose 56.7 mCi to 69.3 mCi) and Co external radiation (total dose 5000 to 6000 R.). (auth)

52252 CLOVERLEAF SKULL SYNDROME. Schuch, A.; Pesch, H.-J. (Univ., Erlangen, Ger.). Z. Kinderheilk.; 109: 187-98(1971). (In German).

A case report is presented describing an infant with systemic skeletal malformation including a cloverleaf skull cleft formation of the facial bones, malformation of the brain, hydrocephalus, and symmetrical notching of hands and feet. This entity was described as clover leaf skull syndrome by Holtermüller and Wiedemann. The etiology of the syndrome is discussed with special reference to lower abdominal x-ray examinations of the mother in early pregnancy as a possible cause of the disorder. The malformations result most likely from a disturbance in the development of the primitive segments involving mainly cranial somites and extremity buds. (auth)

Radiation Effects on Plants

Refer also to abstracts 51608, 51690, 51961, 51962, 52000, 52014, 52016, 52017, 52019, 52020, 52025, 52028–52030, 52032–52036, 52038– 52041, 52044, 52087, 52268, and 52279.

52253 (A/CONF.49/P–213) DNA-REPAIR AND RECOVERY MECHANISMS IN SYNCHRONOUS CHLORELLA CELLS FOLLOWING GAMMA-IRRADIATION. Cabela, E.; Altmann, H. May 1971. 13p. (CONF-710901–89). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

For the present studies light-dark synchronized Chlorella pyrenoidosa were used. Berberine sulphate for vital staining was used to investigate radiation resistance and recovery mechanisms of cells at various stages of the cell cycle after different doses of gamma-irradiation. Cells immediately before DNA synthesis proved to be most sensitive, whereas cells during sporulation showed the highest radioresistance. Alkaline sucrose density-gradient analysis was used to examine repair replication of radiation induced single strand breaks in DNA in different stages of the growth period. Results indicate that the ability to repair DNA strand scissions depends upon the cell stage. Whereas cells in the early beginning S-phase showed a minimum in repair capacity, a complete repair replication in the period of maximum DNA synthesis could be observed. From these results it was concluded that different repair capacities of cells is one of the most important factors responsible for the difference in radiation resistance within the mitotic cycle. (auth)

52254 (JPRS–53801, pp 133-6) RESULTS OF COMBINED EXPOSURE OF CHLORELLA TO VIBRATION AND GAMMA IRRADIATION. Anikeeva, I. D.; Moskvitin, E. V. Translated from Kosm. Biol. Med.; 5: No. 3, 85-7(1971).

Effects of low-frequency mechanical vibration and vibration in combination with gamma radiation on sporulation, viability, and mutability of Chlorella vulgaris were studied. Results demonstrated that joint exposure to irradiation and vibration exerted no influence on the development or mutability of Chlorella and cell viability was not diminished. (H.L.W.)

52255 (JUL–727–BO) INVESTIGATION OF THE PRIMARY REACTIONS IN THE IRRADIATION OF SINGLE-CELLED ALGAE WITH THERMAL NEUTRON THROUGH SUBSTITUTION OF ^{14}N AND ^{10}B. Knoop, Hans-Uwe (Kernforschungsanlage, Juelich (West Germany). Institut fuer Botanik und Mikrobiologie). Feb 1971. 96p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Universitaet, Hanover, Ger.

In algae, Chlorella pyrenoidosa, ^{14}N and ^{10}B were partially substituted through their isotopes ^{15}N and ^{11}B. Thus, biological injury through thermal neutrons could be measured for the important reactions ^{14}N(n,p)^{14}C and ^{10}B(n,α)^{7}Li. Measured were cell proliferation, weight increase, colony formation, and mutation rate. The algae were exposed in the thermal column of a reactor. Radiation injury to the algae increased exponentially throughout dose ranges of 0 to 835 rad for thermal neutrons, 0 to 1350 rad for fast neutrons, and 0 to 2150 rad for x and γ radiation. With respect to thermal neutrons, the ^{14}N reaction caused 93% of the injury, while the ^{10}B reaction contributed insignificantly to the damage. (H.B.G.)

52256 (STI/PUB–271) MUTATION BREEDING FOR DISEASE RESISTANCE. Panel Proceedings Series. Proceedings of a Panel Held in Vienna, 12–16 October 1970. (International Atomic Energy Agency, Vienna (Austria)). May 1971. 256p. (CONF-701052). IAEA $6.00.

Twenty-one papers are included; one paper was abstracted separately. The remaining 20 papers contain information on induction, selection, and utilization of disease resistance in crop plants. (E.E.H.)

For an abstract of an individual paper see: 52263.

52257 SURVIVAL OF CHLORELLA IRRADIATED WITH 645 MeV PROTONS. Sakovich, I. S.; Vekshina, L. K. Kosm. Biol. Med.; 4: No. 3, 86-7(May-Jun 1970). (In Russian).

The survival of Chlorella pyrenoidosa was determined after irradiation with 645 MeV protons at the rate of 30 rad/sec, by culturing in a nutritious medium and observing the optical density of the culture. Survival was 100% for radiation doses of 0.5 and 1.0 krad, dropped to 79.5% for 5 krad, 11.7% at 16 krad, and to 0.021% at 50 krad. Also, with increasing size of the dose, the latent time decreased. Here, the latent time represents the time elapsed before the growth of the cultured cells was inhibited. (K.S.W.)

52258 PHOSPHORUS COMPOUNDS OF RADIORESISTANT AND RADIOSENSITIVE YEASTS. Pomoshnikova, Nina A. (Inst. of Microbiology, Moscow). Antonie Van Leeuwenhoek J. Microbiol. Serol., Suppl.; 35: B21-2(Jun 1969).

Studies were made on the content of nucleic acids and the strength of the nucleic acid bonds with the protein in the radioresistant yeasts, Saccharomyces vini and Torulopsis utilis, and the radiosensitive strains, Saccharomyces lactis and Torulopsis sphaerica. The total content of phosphorus in the yeasts and the DNA in S. vini and S. lactis was essentially the same. However, the DNA in T. utilis was twice that found in T. sphaerica. The cells were treated with 1% trichloroacetic acid and 0.05 N NaOH, and then with hot 0.5 N $HClO_4$ to determine the strength of the nucleic acid bonds. The results showed that in the radiosensitive cultures the correlation between labile and stable nucleoproteins shifted towards the labile. Determination of the DNA in different fractions of the yeast cultures revealed that in radioresistant cultures the DNA is more firmly combined with the proteins of the nucleus. (E.E.H.)

52259 COMPARATIVE STUDY OF THE SYNCHRONIZATION OF CELL DIVISION IN ROOT MERISTEM OF NON-IRRADIATED AND GAMMA IRRADIATED PEA SEEDLINGS. Gudkov, I. N.; Grodzinskii, D. M. (Inst. of Plant Physiology, Kiev). Tsitol. Genet.; 4: No. 6, 509-12(1970). (In Russian).

Maintainence of pea seedlings non-irradiated and irradiated with the 800 rad dose of ^{60}Co γ-rays in a nutrient mixture containing 5-aminouracil (0.07%) caused partial synchronization of cell division in root meristem. Two fading peaks of synchronization were observed, the period of time between which corresponded to duration of the mitotic cycle. Synchronization of irradiated seedlings occurred later than that of non-irradiated ones and duration of the mitotic cycle was longer. The maximum quantity of synchronously dividing cells in irradiated seedlings was considerably lower than that in non-irradiated seedlings; however the probability of cells entering the mitosis is the same. A comparative study of cell division synchronization in root meristems of non-irradiated and irradiated seedlings indicates that the ionizing radiation causes injuries in regulatory processes providing for the inclusion of cells into mitosis in due time, as well as the normal course of the mitotic cycle and its duration. (auth)

52260 SURVIVAL OF SOME DEMATIACEAE SPECIES FOLLOWING ^{60}Co GAMMA IRRADIATION. Bondar, A. I.; Zhdanova, N. N.; Pokhodenko, V. D. (Inst. of Microbiology and Virology, Kiev). Izv. Akad. Nauk SSSR, Ser. Biol.; No. 1, 80-5(Jan-Feb 1971). (In Russian).

Dosage survival curves of two types, sigmoidal for γ-resistant and exponential ones for γ-sensitive strains, were obtained for seven Dematiaceae species (14 cultures). The relation of radioresistance to the concentration of paramagnetic particles was confirmed for the species characterized by sigmoidal survival curves. Radiosensitivity of Dematiaceae cultures displaying exponential dosage curves did not correlate with the concentration of paramagnetic particles which did not exceed $1.1 \cdot 10^{18}$. Radiosensitivity of Cladosporium mutant 7882 showing a reduced melanin content was 9 times lower than that of the initial culture; its dosage curve was of the exponential type. (auth)

52261 VARIETAL DIFFERENCES IN RADIOSENSITIVITY WITH SPECIAL REFERENCE TO DIFFERENT ASPECTS WITH DIFFERENT CROPS. Ukai, Yasuo; Yamashita, Atsushi (National Inst. of Radiation Breeding, Ohmiya, Japan). Gamma Field Symp.; No. 8, 69-81(1969).

From Symposium on genetical control of radiosensitivity; Ohmiya-machi, Ibaraki-ken, Japan (28 Jul 1969). See CONF-690731.

Comparative studies were made on the varietal differences in radiosensitivity between Oryza sativa, Hordeum vulgare, Zea mays, Glycine max, Pisum sativum, and Phaseolus vulgaris. To determine the correlation between radiosensitivity in regard to root growth depression and seedling growth inhibition, air dryed seeds were exposed to γ or x rays. For cytological studies, seeds

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were irradiated with γ rays and, after planting, placed in a dark room. The correlation between radiosensitivity after air dryed seed irradiation and presoaked seed and seedling irradiation was determined by exposing seeds to x rays after presoaking. In rice, barley, peas, and kidney beans, factors determining radiosensitivity were expressed only in air dryed seeds and seeds presoaked for a few hrs. Genetic analysis showed that the radiosensitivity of varieties is mainly controlled by a genetic system in rice, barley, and soybeans. In rice and barley, radiosensitivity was determined by polygenic systems while in soybeans a major genic control was predominant. The results indicated that the mechanisms and genetic systems of varietal differences in radiosensitivity in crops differ among different species. (E.E.H.)

52262 PROTEIN SYNTHESIS AND RIBONUCLEIC ACID METABOLISM IN SOYBEAN EMBRYOS AFTER SEED IRRADIATION WITH γ-RAYS. Naito, Tadao; Yamaguchi, Hikoyuki (Tokyo Univ.). Gamma Field Symp.; No. 8, 95-107(1969).

From Symposium on genetical control of radiosensitivity; Ohmiya-machi, Ibaraki-ken, Japan (28 Jul 1969). See CONF-690731.

Free radicals, nucleic acids, and protein and RNA synthesis were examined in γ-irradiated dry and soaked seeds of two soybean varieties differing in radiosensitivity. No intervarietal differences in the radicals in hypocotyls exposed to high doses were found. In the radiosensitive variety, the ratios of sRNA/rRNA from the hypocotyls of dry seeds increased with irradiation and further increased after soaking. It was concluded that in the radiosensitive variety, the rRNA degraded to smaller molecules. The analysis of the base composition in rRNA did not reveal the presence of the bases that are easily damaged by radiation. This degradation was not caused by the release of ribonuclease by irradiation. There was no intervarietal difference in radiosensitivity for RNA synthesis during the early period following soaking of the irradiated seeds. In the radioresistant variety, radiation produced an overall reduction of protein synthesis. Protein synthesis increased or decreased in the radiosensitive variety during soaking. The processing of a precursor rRNA to 18 S and 25 S RNA as well as the regulation system in protein synthesis are believed to be the determinants of radiosensitivity between soybean varieties. (E.E.H.)

52263 ATTEMPT TO INDUCE RESISTANCE TO SEPTORIA NODORUM AND PUCCINIA GRAMINIS IN WHEAT USING GAMMA RAYS, NEUTRONS, AND EMS AS MUTAGENIC AGENTS. Little, R. (International Wheat Rust Testing Centre, Njoro, Kenya). pp 139-49 of Mutation Breeding for Disease Resistance. Vienna; International Atomic Energy Agency (1971).

From Panel on mutation breeding for disease resistance; Vienna, Austria (12 Oct 1970). See STI/PUB-271; CONF-701052.

Seeds of two varieties of wheat (Maribal Mariache and K358AA, the former susceptible to Septoria nodorum and the latter to stem rust) were treated with γ rays, neutrons, and EMS. Precautions were taken to prevent cross-pollination in M_1 and M_2. The M_3 generation was screened for resistance. No stem-rust resistant mutants were isolated in K358AA but 71 plants resistant to Septoria were selected from mutagen-treated populations of Maribal in the M_3 generation. In addition, critical evaluation of these selections in subsequent generations confirmed that at least 8 of these plants can be classified as induced mutants. (auth)

52264 SENSITIVITY OF LIMA BEAN (PHASEOLUS LIMENSIS MACF.) YIELD TO ^{60}Co GAMMA RADIATION GIVEN AT THREE REPRODUCTIVE STAGES. Bottino, P. J.; Sparrow, A. H. (Brookhaven National Lab., Upton, N. Y.). Crop Sci.; 11: 436-7(May-Jun 1971).

Potted plants of lima beans (Phaseolus limensis Macf. "Fordhook 242") were given a series of 16-hour constant rate exposures to ^{60}Co gamma radiation. The plants were at one of three stages of reproductive development: buds in early pollen development; flowers in anthesis or young pods after fertilization; and large pods containing small partially developed seeds. The decreasing order of sensitivity measured as seed yield was buds, flowers or young pods, and large pods. The 50% yield reduction exposures were 0.42 ± 0.43 kR for buds, 1.47 ± 0.47 kR for flowers and young pods, and 6.34 ± 0.02 kR for large pods, indicating about a 15 fold difference between the most sensitive and most resistant stage. (auth)

52265 RESPONSE OF TOXIGENIC AND NON-TOXIGENIC STRAINS OF ASPERGILLUS FLAVUS TO IRRADIATION. Frank, H. K.; Muenzner, Ruth; Diehl, J. F. (Budesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Sabouraudia; 9: 21-6(Mar 1971).

Condidia-bearing cultures of 3 aflatoxin producing and 3 non-toxigenic strains of A. flavus were irradiated 16 times in 6 months at a dosage of 160–240 krad each time. Subcultures were grown between irradiations and about 70% of 60 subcultures survived all irradiations. Survial was approximately the same in both groups. Surviving subcultures were refrigerated and transferred to fresh medium each 6 months. One, 2 and 3 years after the multiple radiation treatment the subcultures were grown on rice. Of the 3 toxigenic strains, 0, 30 and 50%, respectively, were able to produce aflatoxins after 1 year; 50, 30 and 60%, respectively, after 3 years. Often the aflatoxin yield was much lower in irradiated subcultures than in the parent strain but sometimes it was higher. Two of the 3 non-toxigenic strains remained aflatoxin-negative, while of 14 subcultures of the third strain, 2 were positive after 2 years, and 4 more after 3 years. These results are not due to loss or gain mutations or to repair processes. A. flavus is heterocaryotic and an accumulation of nuclei possessing or not the genetic information for aflatoxin synthesis appears possible in the course of many transfers to fresh medium. This may lead to loss, recovery or gain of the ability to produce aflatoxins. (auth)

52266 EFFECT OF GAMMA-IRRADIATION OF GRAIN SEED ON THE NITROGEN CONTENT OF THE YOUNG PLANTS. Kulesza, Janusz; Kroh, Jerzy; Antoszewska, Lucja (Polytechnic Inst., Lodz, Poland). Zesz. Nauk. Politech. Lodz., Chem. Spozyw.; No. 14, 55-60(1968). (In Polish).

Two varieties of wheat seed and one variety of rye seed were given varying amounts of γ-radiation from a ^{60}Co source: 1, 5, 29, 25, and 100 krad. The 5- and 7-day seedlings, grown from the irradiated seed, were used to establish their length, their total N content, and their dry weight. Increases in total N and dried weight were observed in some plants. Doses of 1 or 5 krad usually stimulated growth, but a radiation dose in excess of 5 krad depressed plant growth. Statistically trustworthy results supporting an increase of total N were obtained only for the rye. (tr-auth)

52267 EFFECT OF γ RAYS AND CHEMICAL MUTAGENS ON REVERSION FREQUENCY OF CHLOROPHYL MUTANTS IN SUNFLOWER. Lyashchenko, I. F.; Ulitcheva, I. I. (Rostov State Univ., Rostov-on-Don, USSR). Tsitol. Genet.; 4: No. 6, 553-9(1970). (In Russian).

Treatment of seeds of chlorophyl/mutants of sunflowers with γ-rays, nitrosoethylurea and dimethyl sulphate induces partial or complete reversions. Some revertants possess valuable economic properties. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 51961, 51996, 52001, 52018, 52024, 52106, 52175, and 52227.

52268 (A/CONF.49/P-538) RADIATION DAMAGE AND REPAIR AT THE MOLECULAR AND CELLULAR LEVELS. Singh, B. B.; Gopal-Ayengar, A. R. (Bhabha Atomic Research Centre, Bombay (India)). May 1971. 30p. (CONF-710901-301). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The damage to cellular DNA is one of the major factors responsible for radiation death of bacteria since various DNA specific events such as thymineless death, uv exposure, and base analogue substitution modify the radiation response. Besides the single and double strand breaks in the DNA, the destruction of bases due to attack of radiolytic products of water is also observed. The DNA damage is repairable in radioresistant strains, and the gram positive microorganisms in general, show greater resistance to γ radiation than the gram negative ones. The studies on mutants of Hemophilus influenzae, with a twenty fold variation in their radiosensitivity, have demonstrated the genetic control of the radiation response of cells. Apart from the DNA, the cellular membrane is also shown to play a significant role in radiation response of cells. In particular, radiosensitizers such as iodine compounds, electron affinic compounds, and sulfhydryl binding agents exhibit their effects at the membrane level, probably by inhibiting the post-irradiation recovery processes. Such compounds are shown to produce short-lived toxic products which influence the postirradiation DNA degradation, and the synthesis of DNA, RNA, and proteins. Post-irradiation incubation of cells with RNAse, on the other hand, shows enhanced recovery. The intra-cellular catalase level in Saccharomyces cerevisias also influences its radiosensitivity and has been found to be increased by aeration or irradiation. The uv response of algae cells Anacystis nidulans and its nitrofurazone resistant strain (NFr) is modified by acriflavine and yeast extract, indicating intereference with the recovery/repair processes. The damage to seeds due to γ radiation or neutrons, which has been measured in terms of chromosomal aberrations, mutation frequencies, and seedling heights, is modified by the moisture content and the post-irradiation storage conditions. In rodents and fish, the thyroid activity and thymus gland are shown to influence their radiation response. The urinary excretion of amines is one of the earliest effects of radiation noticed in mice, and results on the reproductive system, connective tissues, and other types of cells are discussed. (auth)

52269 USE OF ENTERIC BACTERIA FOR THE DETERMINATION OF THE ABSORBED DOSE OF LONG-WAVE X RADIATION. **Kuznetsova, L. A.; Krongauz, A. N.; Rybakov, N. I.; (and others). Radiobiol.-Radiother.; 11: No. 5, 621-7(1970). (In German).**

A method for the determination of the absorbed dose of long-wave x radiation using the survival of intestinal Escherichia coli is described which was used in clinical dosimetry. The method enables the immediate measurement of the absorbed doses in a tissue-equivalent medium. (auth)

52270 EFFECTS OF VARIOUS GAMMA RADIATION DOSES ON THE GROWTH OF AZOTOBACTER CHROOCOCCUM BEIJ. **Nowak, Willy (Bayerische Landesanstalt fuer Bodenkultur, Pflanzenbau und Pflanzenschutz, Munich). Zentralbl. Bakteriol Parasitenk., Abt. II; 122: 573-9(1968). (In German).**

The effects of γ irradiation on aquatic suspensions of Azotobacter chroococcum caused an increase in radioinduced forms. Their growth on agar plates was observed. Microscopic investigation of these forms did not reveal changes in Phaco and different colors after fluorescence staining with acridine orange in comparison with control plates. Irradiation led to a decrease in colonies. The effect was greater the higher the radiation dose. Growth of the colonies on agar plates was retarded with increasing doses. The lethal dose for cultures of Azotobacter chroococcum was above 50,000 R. (F.M.M.)

52271 ULTRAVIOLET SENSITIVITY OF HAEMOPHILUS INFLUENZAE TRANSFORMING DNA. II. A REEXTRACTION STUDY OF INTEGRATION AND REPAIR. **Day III, Rufus S.; Rupert, Claud S. (Univ. of Texas, Dallas). Mutat. Res.; 11: No. 3, 313-26(Mar 1971).**

Repair of uv-irradiated Hemophilus influenzae transforming DNA after its uptake by competent cells was studied by reextracting it and assaying the retrieved material for transforming activity. The novobiocin resistance markers Nb_1 or Nb_2 (the latter consisting of Nb_1 plus the closely linked low level resistance marker Nb_3) in the transforming DNA were used to transform recipient cells either carrying or lacking the Nb_3 marker. The presence of repairable uv damage in reextracted DNA was detected by comparative assays under conditions which either permit or inhibit dark repair during the assay transformation, and by photoreactivation in vitro. The results show that repair of Nb_1 and Nb_2 markers after uptake occurs only when the DNA carrying them has the same mutational state at the Nb_3 locus as the recipient cell genome, in agreement with our previous interpretation of the uv-inactivation curves. Because all recipient cells were made to carry the high level streptomycin marker Sr, which is loosely linked to the novobiocin loci, integration of the transforming DNA into the recipient genome could be followed by the observation of linked Sr Nb double transformations in assaying the reextracted material. It was found that uv-damaged regions of transforming DNA are integrated, whatever the relative states of Nb_3 mutation in the cells and transforming DNA, and that part, if not all, of the intracellular repair taking place when the donor and recipient DNAs are in the same mutational state at the Nb_3 locus, occurs after the integration of damaged DNA into the recipient genome. (auth)

52272 INACTIVATION OF INFLUENZA VIRUS WITH γ RADIATION. Pleceas, M.; Arizan, D.; Hlevca, B. (Institutul de Igiena, Bucharest). Stud. Cercet. Inframicrobiol.; 19: No. 6, 425-7(1968). (In Rumanian).

The inactivating effect of gamma radiations (^{60}Co) on influenza virus PR-8, suspended in normal saline was investigated. The virus was totally inactivated following irradiation with a dose of 2,000,000 R/γ. (auth)

52273 ACTION OF γ RADIATION ON MEASLES VIRUS. Sorodoc, Yolanda; Cepleanu, Maria; Burducea, O.; Cernescu, C. (Institutul de Inframicrobiologie, Bucharest). Stud. Cercet. Inframicrobiol.; 19: No. 6, 437-40(1968). (In Rumanian).

Under the action of gamma radiations emitted by a source of ^{60}Co the infective capacity of the autochthonous measles virus MN strain (non-purified) was destroyed at a dose of $\leq 5 \times 10^5$ R. The hemagglutinating capacity of this strain was not influenced by doses of 1×10^5 up to 2×10^6 R. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 51707, 51961, 51967, 51968, 52184, and 52203.

52274 (A/CONF.49/P-12) ISRAEL FOOD IRRADIATION PROGRAM 1965 TO 1970: APPLICATION OF A CONCEPTUAL APPROACH TO THE COMMERCIALIZATION OF IRRADIATED AGRICULTURAL PRODUCTS. Lapidot, M. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). May 1971. 37p. (CONF-710901-65). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The 1965-1970 Israel Food Irradiation Program, implemented to achieve a reduction in the considerable losses of vegetables and fruits incurred upon storage, is reviewed in detail. This program centered around a preliminary series of screening experiments designed to select the items most likely to benefit from extensive research and development programs which followed. Of the fruits studied citrus, strawberries, and avocadoes showed most promise, while of the vegetables garlic, onions, and potatoes gave the best results. Onions and potatoes were chosen as model items in a commercialization program for which a conceptual approach was defined. An association of agricultural organizations implemented this program in cooperation with scientific research institutes. While the response of the two vegetables to irradiation was under study a detailed economic survey comparing present and proposed potato and onion storage technologies was prepared. This served to clarify the economically critical parameters to be investigated in subsequent storage seasons. Permission to market irradiated potatoes and onions was granted by the Israel Ministry of Health in 1967 and 1968, respectively. According to detailed guidelines prepared by marketing psychologists and economists, consumer acceptance was tested on two hundred tons of potatoes and onions. They were test marketed in diverse areas of Israel and via various marketing channels in 1968/69 and 1969/70. The public showed a preference ranging from 2:1 to 4:1 for the irradiated vegetables. The data obtained were then analyzed with a view to preparing a final commercial publicity campaign. In parallel, data obtained in the pilot scale irradiation and storage operations for the above tests were analyzed by economists to determine the commercial feasibility of a central facility for the irradiation, storage, and retail packaging of potatoes and onions in the thousands of tons. (auth)

52275 (A/CONF.49/P-29) INTRODUCING IRRADIATED FOODS TO THE CONSUMER AND PRODUCER. **Ulmann, R. M. (Proefbedrijf Voedselbestraling, Wageningen (Netherlands)). May 1971. 16p. (CONF-710901-76). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The successful cooperation in the Netherlands between the scientific institutes dealing with food irradiation, the health authorities dealing with the necessary permissions and clearances, and private industry endeavoring to market the irradiated product may promote the introduction of this physical preservation process in other countries. Specifically, in the developing countries where conventional preservation chains are not fully effected, the benefits of this new process may very soon become visible. (auth)

52276 (A/CONF.49/P-115) LABORATORY ACTIVITIES ON FOOD IRRADIATION IN INDONESIA. Abdullah, Nazir; Siagian, E. G.; Isnaeni, M.; Ismachin, M. (National Atomic Energy Agency, Djakarta (Indonesia). Pasar Djumat Research Centre). May 1971. 14p. (CONF-710901-159). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Food preservation by ionizing radiation has been investigated since 1968. The activities were concentrated on disinfestation of rice, radiopasteurization of marine products, and the sprouting inhibition of white potatoes. Several aspects have been investigated and very promising results obtained. In order to control the rice weevil (Sitophilus oryzae L.), irradiation doses of 8 to 12 krads by ^{60}Co were found sufficient to kill all stages of this rice weevil within two weeks. Up to 1 Mrad thiamine content in the grain was found unchanged. Taste evaluations carried out by twelve panelists found no differences between cooked irradiated rice and the control, even up to a radiation dose of 18 krads. One species of fish, i.e. tenggiri (Scomberomorus spp.) which is available in great abundance in Indonesia waters was chosen for radiopasteurization

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studies. Total plate count (TPC) and taste evaluations by a group of panelists were used as criteria for determination of shelf life. All the products were stored at chilling temperature. Irradiation up to 450 krads was found most favorable as it could extend the shelf-life up to three times the control. Several studies have been done on irradiation of white potatoes. Doses up to 18 krads have been used and it was found that the doses of 8 to 10 krads were sufficient for inhibition of sprouting up to five months at ambient temperature. Investigations on some other food items treated with gamma irradiation are in progress. (auth)

52277 (A/CONF.49/P–120) FOOD IRRADIATION IN SWITZERLAND. Zehnder, H. J. (Swiss Federal Research Station for Arboriculture, Viticulture, and Horticulture, Waedenswil). May 1971. 5p. (CONF-710901–162). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Compared to other countries, Switzerland only began to seriously consider the possibilities of food irradiation relatively recently. In order to coordinate Swiss efforts in this field, a Federal Commission for Food Irradiation in which both economic and governmental interests are represented was brought into existence in 1968. It was anticipated that this commission would be informed of international developments in that field and would be in a position to carry out independent research work. Irradiation of tomatoes, strawberries, apricots, beans, potatoes and wheaten flour has been carried out since 1965. Work on the first four products has aimed at lengthening their shelf-life, while potatoes should be industrially usable following a six-month storage period. Irradiated flour should be stored for emergency purposes instead of grain and must be preservable for a minimum of two years. Due to unfavorable results with apricots, work in this direction was discontinued. Despite very good results with irradiation of strawberries and beans, these projects were temporarily abandoned. Investigations with tomatoes showed that irradiation was very effective when the fruit was harvested during a dry period, whereas harvesting after a wet weather period predisposed the fruit to microbial infection and resulted in ready decay after irradiation. The changes occurring in various components of irradiated potatoes are being investigated. The irradiation of dark wheaten flour did not succeed in making it preservable for longer periods. An attempt will, therefore, be made to achieve success by either combined treatments or by the use of white flour. In Switzerland we are aware that in the field of food irradiation decisive progress can only be made through international collaboration and our efforts are, therefore, directed towards participation in promising international projects. (auth)

52278 (A/CONF.49/P–136) ADVANCES IN REDUCING FOOD LOSSES AND INCREASING FOOD PRODUCTION IN U.A.R. Kamal, T. H.; Roushdy, H. M.; El-Kholi, A. F.; (and others) (Atomic Energy Establishment, Cairo (Egypt)). May 1971. 16p. (CONF-710901–79). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Since the local hot weather is responsible for loss in animal production, bioclimatological investigations have been undertaken to clasify the mechanism of heat stress in farm animals, to alleviate the heat load imposed on them and to identify heat tolerant animal. ^{45}Ca, ^{32}P, ^{40}K, ^{131}I, ^{51}Cr and ^{3}H have been utilized to achieve such goals. Studies on application of gamma radiation for extending storage life of fish, onion, garlic, potato, citrus, and apricot are performed. The biochemical mechanisms underlying this treatment, and organoleptic properties have been investigated. In an attempt to eradicate insects, sterile male and/or female techniques have been practiced on a number of agricultural insect pests; the cotton leaf worm, the lesser cotton worm, the two-spotted spider mite, the fruit fly and the broad bean weevil. The mechanisms of action of insecticides and their metabolism in plant and animal tissues have been studied using ^{32}P and ^{14}C labelled carbamate and organophosphorus insecticides. For increasing food production, corn, peanuts and tomato seeds have been exposed to gamma radiation to induce useful mutants. In three generations of corn and two generations of peanuts, some of the exposure levels produced few plants exceeding the respective controls' limits in many useful characters. Tomato showed significant earliness in flowering and ripening and in fruit yield. Irradiation of olive and onion seeds stimulated seedlings growth and germination period. In soil research, efficient use of fertilizers as well as the mechanisms affecting fixation and release of nutrients have been studied. Relative efficiency studies on some phosphate fertilizers using ^{32}P indicated that superphosphate surpassed other phosphate sources. In animal nutrition problems total body solids, mineral, water and protein metabolism have been studied. Tritiated water has been used to determine dry body weight gain. Such technique has been utilized to measure this gain after diethylstilbestrol implantation in farm animals. (auth)

52279 (A/CONF.49/P–162) CANADIAN STUDIES ON APPLICATIONS OF ISOTOPES AND RADIATION IN AGRICULTURE AND FOOD PRESERVATION. MacQueen, K. F. (Atomic Energy of Canada Ltd., Ottawa (Ontario)); Ketcheson, J. W. (Guelph Univ., Ontario); Lapins, K. O.; Proverbs, M. D.; (and others) (Department of Agriculture (Canada). Research Station, Summerland, B. C.). May 1971. 18p. (CONF-710901–179). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Isotopes and radiation have been used extensively in studies to improve food production and reduce food losses. Four hundred educational or research institutes are licensed to use radioactivity and twenty cobalt-60 irradiators are installed across Canada for biological and food research. Low-dose gamma irradiation of seeds and its effect on subsequent growth have been studied for four years. Although stimulatory effects were variable, vegetable crops responded more favorably than cereals. The earlier, better concentrated, and higher yields in several vegetable crops appear commercially attractive where once-over machine harvesting is employed. Using the sterile-male technique, good control of the codling moth in four apple orchards was obtained when the ratio of sterile to wild moths was 30: 1 or more. The release of partially sterile males together with fully sterile females was even more effective. Radiation-induced mutants with commercial potential have been introduced: a dwarf sweet cherry, a self-fertile sweet cherry, and an early maturing apricot. Continuing field and laboratory experiments using isotope techniques have made possible a better understanding of the complex soil-plant environment and have led to significant practical applications, such as in fertilizer management. Isotope techniques have been used for studies on animal physiology, nutrition and health. Studies on animal health include causes of tumor formation with important implications for human health. Studies of radiation preservation of foods include: sprout inhibition, disinfestation, extension of shelf-life, elimination of specific pathogens (salmonella), microbiological safety and wholesomeness. The Canadian government permits irradiation processing for potatoes, onions, wheat and wheat flour; petitions for additional items are under review or in preparation. (auth)

52280 (A/CONF.49/P–256) PRESENT STATUS OF FOOD IRRADIATION IN JAPAN. Sato, T. (Japan Atomic Energy Research Inst., Takasaki. Takasaki Radiation Chemistry Research Establishment). May 1971. 22p. (CONF-710901–97). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In 1967, the JAEC established a national research program regarding the affects on foods by irradiation. This program is scheduled to continue until 1975, and nine selected foods are expected to be commercialized. These foods are: potatoes and onions (sprout inhibition), rice and wheat (insect control and pasteurization), mandarine oranges (pasteurization), processed marine products (boiled fish paste and one other item (pasteurization)) and livestock products (Vienna-type sausages and one other item (pasteurization)). Food irradiation facilities for joint usage are being constructed at the Takasaki Radiation Chemistry Research Establishment of the JAERI. Investigation on the sprout inhibition of potatoes and onions has been conducted on a pilot-scale since 1967. In the case of potatoes, 7 to 15 krad irradiation during the dormancy term inhibited sprouts effectively for 6 to 8 months in any variety. On the other hand, there are certain differences between the varieties of onions; however, 7 krad irradiation effectively inhibited sprouting for 8 months in the variety with the largest harvest. An investigation on quality changes and the taste of rice was conducted in 1967 and 1968. There is no significant difference between irradiated and unirradiated rice at doses of 10 to 15 krad and after a 3 month storage period. Some fundamental data have been obtained on the pasteurization of Vienna-type sausages. There was no change of taste or slime when irradiated with 0.5 Mrad and refrigerated for 7 days below 10°C. Studies in progress with potatoes, onions, and rice include: toxicity studies (Short-term, long-term, generation); effects of irradiation on vitamin contents and change in nutritional constituents; production of abnormal substance; and setting-up of practical method of detection. Reports on potatoes and onions are being prepared, and the application for permission of human consumption will be submitted to the Japanese Minister of Welfare in 1971. (auth)

52281 (A/CONF.49/P–323) HUNGARIAN RESEARCH ON THE UTILIZATION OF ATOMIC ENERGY IN FOOD AND AGRICULTURE. Vas, K. (Central Food Research Inst., Budapest, Hungary). May 1971. 10p. (CONF-710901–109). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Applications of an 80 and a 50 kCi^{60}Co irradiator, as well as a number of smaller radiation sources, in the production and preservation of food supplies in Hungary are discussed. Increased food production was the aim of investigations into the radiation-stimulation of crop plants. Experiments carried out on the radio-induced stimulation of growth and food yield of sugar beet, maize, tomatoes, potatoes, barley, and radishes showed statistically significant improvement either in quantity or in quality. Application of the radioinduced sterility principle of insect control to codling moth and beam weevil reached the stage of field cage experiments. Mass-rearing methods are now being designed for these and other species. In the field of food preservation, increasing the storage life of fresh fruits and vegetables (apple, appricot, tomatoes, potatoes, onions, mushroom, and beets) by small radiation doses, affecting tissue metabolism only, was studied thoroughly. Destruction of microorganisms was the objective of irradiation experiments with harvested agricultural crops (wheat, maize, strawberry, peeled and prepackaged vegetables) and bread. Radiation processing of spices (paprika) and sugar was found practicable. Combination of ionizing radiations with mild heat treatment or heat removal showed promise with canned fruits, vegetables, and meat products, as with prepackaged meat and poultry. The wholesomeness of irradiated food was carefully investigated, the methodology of testing biologically active substances, like spices, being of primary concern. The economic feasibility of food irradiation was closely studied and found practicable. (auth)

52282 (A/CONF.49/P–628) PRESERVATION OF POWDERED FOOD PRODUCTS BY IRRADIATION: ADVANTAGES AND POSSIBILITIES OF THE METHOD; APPLICATION TO THE CASE OF MAIZE STARCH. Saint-Lebe, L.; Berger, G. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Jul 1971. 16p. (CONF-710901–445). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The food industry is obliged to innovate at an ever-increasing rate. The most elaborate foods will be, and in fact already are, presented in powder form for ease of transport, storage and especially use. In most cases they will be a mixture of simple components, extracts of traditional agricultural products of which the nutritive elements will be better preserved and employed, or obtained by new techniques such as protein synthesis from the bacterial break-down of hydrocarbons. The problem of the disinfection of such human and animal foods will be all the more acute in that cooking will not always be necessary. Technologists today lack methods to disinfect a powder and sometimes call on products which may be toxic. Irradiation, alone or combined with other treatments, could be the answer because it is easy to employ: it is applied to foods already packed, the minor risks of toxicity will have to be estimated in each case, the cost will be low because of the continuous nature of the production. The first stage of the research undertaken at the CEA by the Radioagronomy Service is centered on maize starch, a basic component of a large number of manufactured food products and a typical example of the class of starches and certain of their derivatives. The work is carried out in collaboration with firms in the starch industry which take charge of the microbiological and technological aspects. The problem of toxicological evaluation is tackled in three directions: standards tests on animals, experiments on bacterial cultures and above all identification and analysis of the products formed during irradiation. The results obtained in these three directions are given and an irradiation test on starch is described. (auth)

52283 (A/CONF.49/P–696) USE OF IONIZING RADIATION IN FOOD TECHNOLOGY. Rogachov, V. I.; Kardashev, A. V.; Osipov, V. B.; Bregadse, W. D.; (and others) (State Atomic Energy Committee, USSR). Aug 1971. 18p. (CONF-710901–459). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The study of the possibility of using ionizing radiations in the food industry was concentrated on extending the shelf life and the reduction of the spoiling of the agricultural raw materials and half-made and ready-made products. Considerably less attention was attached to the use of ionizing radiations directly for the intensification of technological processes and the increase of the quality of products in food industry. The experimental work in the USSR demonstrated the possible use of the ionizing radiation in this field. The results of these experiments as applied to the production of flour, starch, agar, fruit juices, jelly and jam, grape wines and cognac, mineral water, tap water and other products are given in the report. Some data about the changes taking place in the irradiated materials are presented. In most cases radiochemical processes result in the accumulation of free radicals, in changes in the oxidation-reduction processes, and destruction of some compounds; but under some conditions polymerization processes take place. The morphological and physico-chemical changes which arise from the effect of the ionizing radiations in plant tissue are of great significance. In conclusion some proposals about the practical use of the ionizing radiations in technological processes of food industry are given. Depending on the dose involved and the kind of product the positive effect of ionizing radiations may result in: acceleration of the technological process; extending of the shelf-life; increasing of output of ready-made products; improving of the quality of products; and the making of articles with new properties in comparison with products made by traditional methods. (auth)

52284 (A/CONF.49/P–740) NUCLEAR METHODS OF REDUCING FOOD LOSSES. Sreenivasan, A.; Aiyar, A. S.; Bongirwar, D. R.; Kumta, U. S.; (and others) (Bhabha Atomic Research Centre, Bombay (India)). Jun 1971. 18p. (CONF-710901–422). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Radiation provides an effective means for food preservation through control of food borne spoilage organisms in perishables, by eradication of pests in stored grains and by retarding physiological processes such as ripening and sprouting. Recognizing these potentials, the Bhabha Atomic Research Center, has, during the last few years, been carrying out detailed studies on prevention of food losses using specially designed cobalt 60 radiation sources. Specific programmes of research relate to shelf-life and storage changes in perishables such as fruits, vegetable products, sea foods and other meat products; sterilization (radappertization) and pasteurization (radurization) of foods through judicious use of ionizing radiation and other physicochemical treatments or bioengineering techniques; disinfestation of stored food grains; and biochemical micro-biological, nutritional and other wholesomeness aspects of irradiated foods. Promising observations relate to inhibition of sprouting in potatoes and onions; delayed ripening of fruits like mango and banana; disinfestation of stored wheat; and extension in shelf-life of shrimps, Bombay duck and pomfrets stored "as-is" at sub-room temperatures; dehydro-irradiated or pre-cooked shrimps and Bombay duck laminates stored at ambient temperatures; and dried sea foods of commercial value which otherwise get extensively infested with insects and moulds during storage. Scaled-up operations pertaining to these processes are in progress for cost benefit analyses, for development of feasible technologies and for design of plant and equipment for pilot scale operations. Concurrently, basic studies are being carried out with insects and moulds during storage. The current status of the food irradiation programmes, the scope for their commercial adoption, the efforts being initiated towards legislation and marketing of irradiated foods, the methodologies for wholesomeness evaluation and the need for uniformity, internationally, in acceptance practices will be reviewed. (auth)

52285 (A/CONF.49/P–772) JOINT PROGRAMME OF FAO AND IAEA ON THE APPLICATION OF ATOMIC ENERGY IN FOOD AND AGRICULTURE. Sigurbjoernsson, B.; Fried, M. (Joint FAO/IAEA Div. of Atomic Energy in Food and Agriculture, Vienna (Austria)). Jul 1971. 20p. (CONF-710901–465). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The joint programme was established in 1964 by the creation of the Joint FAO/IAEA Division, located in Vienna. The programme has been carried out in the following subject matter fields: soils, irrigation and crop production; plant breeding and genetics; animal production and health; insect eradication and pest control; pesticide residues and pollution; and food preservation. In addition to regular and field programme activities the Division has technical responsiblity for the Agricultural Section of the IAEA Laboratory. The bulk of the regular programme is carried out through over twenty internationally coordinated research programmes based on some 180 research contracts and research agreements. Coordination is mainly accomplished by convening annual or periodic meetings of contract holders in each programme. The Division has organized 14 international symposia and conferences; annually convenes

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6 to 8 expert panels on the various subject matters, and has operated 23 training courses. In addition, the Division has been responsible for a number of technical assistance field projects and fellowships, and three UNDP/SF projects. The joint programme is almost entirely orientated towards developing countries and aims at the promotion of atomic energy for practical purposes of immediate benefit to further food production and to enhance crop, livestock, and food protection. The paper describes the joint programme and some of the results obtained. (auth)

52286 (EURISOTOP—43) WORKSHOP MEETING OF BUREAU EURISOTOP ON APPLICATION OF IRRADIATION TECHNIQUES IN THE FOOD INDUSTRY, BRUSSELS, FEBRUARY 23–24, 1967. **Mulkens, R. [ed.] (European Atomic Energy Community, Brussels (Belgium). Bureau Eurisotop). 1971. 245p. (In French). (CONF-670224).**

The introductory paper consisted of a general exploration of food irradiation problems in different countries and of particular problems in this community. Seven papers were presented on applications of radiation techniques to food products of plant and animal origin. Additional papers were presented on radiation technology, sanitary and legal aspects of irradiation, initiative taken by industry in different member states, and suggestions concerning action to be taken by the Bureau Eurisotop. (H.L.W.)

52287 SPOILAGE UNITS OF RADURIZED BOMBAY DUCK (HARPODON NEHEREUS). **Kumta, U. S.; Alur, M. D.; Mavinkurve, S. S.; Lewis, N. F. (Bhabha Atomic Research Centre, Trombay, India). J. Food Sci.; 36: No. 5, 831-2(Jul-Aug 1971).**

The effects of storage temperature on suppression of the spoilage rate of radurized (0.1 Mrad γ radiation) and unirradiated fillets of Bombay duck (Harpodon nehereus) were investigated. It was found that the spoilage rate was temperature dependent and that radurization effectively suppressed the spoilage rate if the irradiated products were stored below 3°C. (E.R.B.)

52288 DISINFESTATION OF INSECT-INFESTED WHEAT BY MEANS OF IONIZING RADIATION. **Saur, W.; Hoigne, J. Muehle: 107: No. 8, 104-6(1970). (In German).**

The biological effects, particularly disinfection efficiency, in relation to dose after irradiation of beetle-infected cereals are discussed in detail. The up-to-date data for the most frequently occurring pests are briefly compiled: corn-beetle (Sitophilus granarius), rice-beetle (Sitophilus oryzae), and meal-beetle (Tribolium confusum). (INIS)

52289 EFFECT OF STERILIZATION ON THE PROTEIN QUALITY OF FEED MIXTURES. **Eggum, Bjoern O. Z. Tierphysiol. Tierernaehr. Futtermittelk.; 25: 204-10(Sep 1969). (In German).**

Two methods of sterilizing feed mixtures were investigated in trials using rats; autoclaving and radioactive irradiation. The following criteria were used for evaluating the effect: composition of amino acids, true digestibility and biological value, as well as net utilization of protein. It was shown that autoclaving of the feed mixture may considerably lower the concentration of individual amino acids (lysine, methionine, cystine) and thus the biological value. In these works sterilizing the feed by irradiation had no negative effect on the composition of amino acids. Doubling the necessary dose of irradiation had only a very slight negative effect. (auth)

52290 BEHAVIOR OF FRESH SOLIDS UNDER THE INFLUENCE OF IONIZING RADIATION. **Gallina, Charles Onofrio. New Brunswick, N. J.; Rutgers—The State Univ. (1971). 248p. University Microfilms Order No. 71-20,050.**

Thesis.

An investigation was undertaken to determine and evaluate the behavior of fresh solids under the influence of ionizing radiation. Subsequent effects of irradiated fresh solids on the anaerobic digestion process and sludge handling characteristics were also studied. The ionizing radiation consisted of secondary electrons resulting from the interaction with matter of decay radiation from spent uranium fuel rods and cobalt-60 gamma rays. High temperature and pressure were utilized in order to provide a basis of comparison with another high-energy system. The fresh solids were obtained from the Marboro State Hospital Sewage Treatment Plant and therefore were relatively free of industrial waste components. Total solids ranged from 4.3 to 5.6% with Volatile Solids from 82.3 to 84.4%. pH ranged from 5.30 to 5.40 pH units. All samples were irradiated within 24 hrs of collection. The range of radiation doses utilized was from 0.025 to 100 Megarads with dose rates ranging from 6.0 to 0.1 Megarads per hour. The irradiated fresh solids were analyzed for various chemical and biological changes, subjected to anaerobic digestion with associated concurrent analyses, and examined with respect to various sludge handling characteristics as measured by the parameters of specific resistance and the coefficient of compressibility. Irradiation of the fresh solids system resulted in a relatively rapid conversion of a significant fraction of complex proteins, fats, and carbohydrates to their basic components of amino acids, fatty acids, and glycerols, basic glucose units, and various simple organic compounds. These in turn were rapidly converted to primarily volatile acids by a number of radio-degradation mechanisms. Due to the anaerobic nature of the system, radiation-induced polymerization of these volatile acids and their precursors begins to affect the radio-degradation of complex materials at doses in excess of 2.0 Megarads. At doses in excess of 10 Megarads, radio-polymerization products predominate with a related reduction in the overall biodegradability increasing with dose. Subjection of irradiated fresh solids to anaerobic digestion results in increased rates and extent of digestion for doses up to 10 Megarads. The greatest increase in the rate and extent of digestion is observed in the 2.0 Megarad sample, resulting primarily from a high volatile acid concentration and minimum interference due to radiation-induced polymerization. For samples irradiated in excess of 10 Megarads, severe inhibition of digestion is observed, the inhibition increasing with dose and due primarily to the aforementioned polymerization mechanisms. Radiation-induced sterility of the fresh solids exhibited no adverse effects on the digestion process. Due to the radiation-induced destruction of hydrophobic and hydrophilic colloid stability, sludge handling characteristics as measured by specific resistance and the coefficient of compressibility improved with dose. Due to saturation effects arising from the formation of large solute particles, sludge handling characteristics are observed to deteriorate in doses in excess of 5.0 Megarads when high vacuums are utilized for filtration. Effects on the sludge handling characteristics of the irradiated fresh solids are carried through anaerobic digestion process and are observed to some extent in the digested solids derived from them, the greatest improvement being in the digested solids derived from the digestion of fresh solids irradiated to a dose of 5.0 Megarads. (Diss. Abstr. Int., B)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 52932, 52940, and 52967.

52291 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. Juli 1971. Band 5, Heft 7. 182 Referate (Register-Nr.2538-2911), 49 Referate (Register-Nr.325 T-373 T). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. July 1971. Vol. 5, No. 7. 182 Abstracts (Register No. 2538-2911), 49 Abstracts (Register No. 325 T-373 T)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H (1971). 121p. (In German and English).

52292 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. Juni 1971. Band 5, Heft 6. 152 Referate (Register-Nr.2228-2537), 54 Referate (Register-Nr.271 T-324 T). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. June 1971. Vol. 5, No. 6. 152 Abstracts (Register No. 2228-2537), 54 Abstracts (Register No. 271 T-324 T)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H (1971). 103p. (In German and English).

Corrosion and Erosion

Refer also to abstracts 51717 and 52417.

52293 (A/CONF.49/P-296) MILD STEEL IN THE PRIMARY CIRCUIT OF WATER COOLED REACTORS. Videm, K.; Lunde, L.; Aas, S. (Institutt for Atomenergi, Kjeller (Norway)); Fjellestad, K. O. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). May 1971. 16p. (CONF-710901-198). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The primary steam pipe line of the Halden Boiling Heavy Water Reactor is made of mild steel. Corrosion specimens of the same material were exposed in the primary system of the reactor, in the water and steam phase in the pressure vessel, the main steam line, and in the subcooler circuit. Extensive out-of-pile loop experiments have also been carried out in water and steam with the same purity and oxygen content as the reactor. The in-pile corrosion of specimens and pipe line was very low and in good agreement with the out-of-pile tests. The low corrosion rate is explained by the theory that oxygen in the range of 1 ppM and below is an effective corrosion inhibitor for mild steel in pure high temperature water. A significant increase of corrosion rate due to neutron flux was found for the specimens exposed in the reactor core. The low corrosion rate, the low release of corrosion products, and the small consequences of mild steel corrosion on the water chemistry, show promise for the use of mild steel components in the primary circuit of water-cooled power reactors. (auth)

52294 (A/CONF.49/P-576) CORROSION PROBLEMS RAISED BY THE USE OF STEELS IN THE CONSTRUCTION OF STEAM GENERATORS FOR NUCLEAR REACTORS. Coriou, H.; Darras, R.; Grall, L.; (and others) (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Apr 1971. 14p. (In French). (CONF-710901-245). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The steels used in the construction of steam generators include ferritic and austenitic types. In water at 350°C, ferritic steels containing 2.25% chromium are sufficiently corrosion-resistant and are not sensitive to corrosion under stress. Austenitic chromium–nickel–iron alloys and steels oxidize very little but under mechanical stress the following phenomena can appear: transgranular cracking of Type $^{18}/_{10}$ steels in the presence of chlorides; intergranular cracking of nickel-rich alloys, particularly structurally hardened types, in pure water; and absence of cracking in alloys of intermediate nickel content, between 30 and 40%. In addition, a study of the corrosion of austenitic alloys in steam at 600°C has shown the favorable effect on oxidation of additions of nickel, chromium, molybdenum, silicon. Here again, a sensitivity to intergranular cracking under stress is observed in nickel-rich alloys. The long-term behaviors of various ferritic steels containing between 2 and 9% chromium and of nonalloyed steels or austenitic steels in flowing sodium, are compared between 475 and 650°C. At 475°C, stabilized or non-stabilized ferritic steels suffer negligible weight losses, show no appreciable decarbonization, and retain their original mechanical properties. Ordinary steels are strongly decarbonized under the same conditions. At 650°C, on the other hand, non-stabilized 2% chromium steel shows considerable decarbonization. This phenomenon does not affect 9% chromium steel which presents a degree of corrosion lower than 0.5 mg/cm^2 after 6,000 hours treatment, similar to that of austenitic steels. Finally, all steels suffer a limited preferential attachment at the grain boundaries. (auth)

52295 (AD-720724) DEVELOPMENT OF OXIDATION-RESISTANT HAFNIUM ALLOYS. Final Report, September 1, 1969–August 31, 1970. Hill, V. L.; Nichols, H. R. (IIT Research Inst., Chicago, Ill.). 30 Sep 1970. Contract N00019-70-C-0120. 66p. (IITRI-B-6099-4). NTIS.

Oxidation-resistant hafnium-base alloys were investigated as cladding for niobium- and tantalum-base alloys. Oxidation behavior of other combinations of Group 4B-5B alloys was also studied. Clad composites consisting of Nb-752 and Ta-10W clad with Hf-Ta-Cr-B-Al and Hf-Ta-Cr-Si alloys were exposed at 2200, 2500, and 2700°F. Oxidation life varied from about 100 hr at 2200°F to 25 hr at 2700°F. Failure of the composites generally occurred at edges between the picture frame and substrate. The Hf-Ta-Cr-B-Al alloy indicated greater tolerance to surface defects than the Hf-Ta-Cr-Si alloy. Oxidation studies of modified Group 4B-5B alloys at 2000 to 2500°F showed that oxidation resistance could be developed in several systems. The minor alloying additions employed were chromium, boron, niobium, silicon, yttrium, vanadium, and combinations of these elements. Chromium-silicon additions were the most effective in improving oxidation resistance in nearly all systems, although Cr-Al-Si combinations were also effective in Nb-Ti alloys. X-ray diffraction examination of oxides developed in oxidation-resistant hafnium-base alloys suggested that the oxide structures, probably a complex Hf-Ta oxide, were similar for all alloys. A model for the oxidation resistant obtained in Hf-Ta alloys is proposed. (auth) (USGRDR)

52296 (AD-721321) HIGH-TEMPERATURE OXIDATION OF NIOBIUM-10 AT. PERCENT CHROMIUM ALLOY. Rosa, C. J.; Chen, G. C. (Cincinnati Univ., Ohio. Dept. of Materials Science and Metallurgical Engineering). Feb 1971. Contract DAHC04-69-C-0016. 64p. (THEMIS-71-19; AROD-T-4:29-E). NTIS.

Oxidation kinetics of Nb-10 at. % Cr alloy were studied at 900, 1000, and 1100°C under oxygen pressures from 100 to 760 torr. At 1000 and 1100°C the oxidation kinetics are lower than for pure Nb and the improvement is attributed to modifying effects of Cr cations dissolved in alpha–Nb205. At 900°C the oxidation rates of the alloy are higher when compared with pure Nb and the decrease in oxidation resistance is related to polymorphic transformation in Nb205 scale. (auth) (USGRDR)

52297 (CONF-711001-(Vol.1), pp 397-407) OXIDATION OF ERBIUM METAL. Loescher, D. H. (Sandia Labs., Albuquerque, N. Mex.). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

In order to obtain information on the oxidation of erbium metal, an ellipsometer was used to measure the thicknesses of oxide films which form on the metal when it is exposed to air at pressures between 10^{-9} torr and 625 torr and at temperatures between 23 and 293°C. The measurements at low pressures show that as much as 10 nm of oxide can form at pressures in the 10^{-6} torr range. The measurements at atmospheric pressure show that an oxide film 6 to 12 nm thick forms very rapidly when erbium is exposed to air. It was also determined that at ambient temperature and pressure the growth of the oxide obeys logarithmic kinetics. However, at temperatures from 160 to 293°C the film thickness, d, is related to the time, t, by an equation of the form $d = At^{\alpha}$ in which A depends on the temperature and moisture content of the air and in which $\alpha = 0.37 \pm 0.04$. (auth)

52298 (EUR-4460) COMPATIBILITY OF Zr-2.5 PERCENT Nb/Na AT 400°C. Henry, B. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1970. 14p. (In Italian). Dep. NTIS (U. S. Sales Only).

The oxidation and hydriding in sodium at 400°C of Zr–2.5% Nb samples cut from reactor pressure tubes were evaluated after treatment in a capsule during 1000 hr. The experiment was conducted with relatively impure sodium. In this environment, it was found that the oxidation rate remains very low, and the hy-

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driding rate is quite significant but may be drastically lowered by a pre-oxidation treatment of the zirconium alloy. (auth)

52299 STABILITY OF IRON AND NICKEL DURING HEATING IN CONTACT WITH REFRACTORY COMPOUNDS. Yurchenko, O. S. (Kiev Engineering Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 1, 35-8(Jan 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 1, 45-9(Jan 1971).

Results show that the melting of a metallic phase in contact with refractory compounds is due to low-melting-point eutectics. This reaction was caused by diffusion of the nonmetallic component of the refractory compound into the metal being investigated. In contact with the compounds studied, iron is more stable than nickel. Borides and silicides are the least stable compounds with respect to Ni and Fe, Fe–ZrB_2 and Fe–WSi_2 being the most stable pairs incorporating these compounds. In contact with Ni and Fe, carbides are more stable than borides or silicides. The greatest stability is exhibited by systems composed of Ni and carbides of the metals of Group VI, and by the systems Fe–ZrC and Fe–WC. Nitrides and oxides are the most stable compounds with respect to the metals investigated. (auth)

52300 ANALYSIS OF CORROSION OF STAINLESS STEEL IN A SODIUM AND HIGH RADIATION ENVIRONMENT. Anno, J. N. (Univ. of Cincinnati); Walowit, J. A. Nucl. Technol.; 10: No. 1, 67-75(Jan 1971).

The effects of radiation on the corrosion of stainless steel in a sodium environment are explored by use of an analytical model of the corrosion process which divides it into leaching and "bulk corrosion." Leaching is assumed to be diffusion controlled and bulk corrosion is assumed to occur linearly with time. The predictions of the model indicate that out-of pile corrosion weight loss undergoes an initial transient behavior and then becomes linear with time. Further, the ferrite layer formed on austenitic steel reaches a limiting value depending on the diffusion coefficients in the ferrite and the rate of bulk corrosion. Analysis of the effects of fast neutron sputtering on the process shows that the principal effects will be (1) to shorten the time required for the weight loss to become linear, (2) to increase the "equilibrium" corrosion rate, (3) to shorten the time required for the ferrite layer to reach its equilibrium value, and (4) to decrease the thickness of the ferrite layer. (auth)

Preparation and Fabrication

Refer also to abstracts 51735, 52939, and 54087.

52301 (A/CONF.49/P–291) PROPERTIES AND MANUFACTURE OF ZIRCALOY CLADDING TUBES. Videm, K.; Aas, S.; Lunde, L.; Lunde, K.; (and others) (Institutt for Atomenergi, Kjeller (Norway)). May 1971. 17p. (CONF-710901-196). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The specifications of Zircaloy cladding tubes are discussed in light of in-pile behavior and of the fabrication steps which determine the properties of the tubes. In general, increased strength is achieved at the expense of ductility. By adjusting the relative reduction of the cross section and wall thickness of the tube and the annealing treatment, the anisotropy of Zircaloy can be utilized to achieve improved properties in the directions of maximum stress. Preferred orientation can also be used to suppress the tendency to neck radially for small deformations in the tangential direction. The effects of various surface treatments on the quality of the surface and on the behavior of the material have been studied. The present trend in cladding tube specifications seems to be towards stricter requirements to dimensional tolerances, mechanical properties, and surface roughness. More stringent requirements can be taken care of with the present production techniques, and will have only a minor influence upon tubing costs provided that a high raw material gain can be maintained. (auth)

52302 (BDX–613–242) ELECTROPOLISHING CVD TUNGSTEN. Interim Report. (Bendix Corp., Kansas City, Mo.). May 1971. Contract AT(29-1)-613. 31p. (CONF-710902–1). Dep. NTIS.

From fourth annual meeting of the international metallographic society; Denver, Colo. (21 Sep 1971).

A detailed study was made of using electropolishing to reveal various microstructures in chemical vapor deposited tungsten. The voltage-current relationship was established and a voltage range was found for revealing in the microstructure markings produced by plating parameter changes. Surface microtexture produced by the several polishing procedures was correlated with deposit hardness and transport conditions. (auth)

52303 (CONF-701002–, pp 488-99) STANDARD FOIL PREPARATION. Lauer, K. F. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The Central Bureau for Nuclear Measurements (CBNM) of Euratom has an extensive program of foil preparation and assaying. This program is devoted to the development and research of different techniques for foil preparation, the determination of isotopic compositions of foil material, and the development of methods for foil assaying by nondestructive methods and by quantitative destructive methods after the foils have been used. The spread found in the fission cross sections, half-lives, and many other categories of nuclear data has led just recently to a more thorough examination of foil production and particularly of assaying. Problems encountered during preparation and assaying of "standard" layers used for the measurement of neutron standards or flux densities are discussed briefly. (auth)

52304 (CONF-711001–(Vol.2), pp 645-56) THERMAL MECHANICAL TREATMENTS OF Mg–11Y ALLOY SHEET. Saia, A.; Edelman, R. E. (Frankford Arsenal, Philadelphia, Pa. Pitman-Dunn Research Labs.). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Various thermal mechanical treatments were carried out on a binary age hardenable magnesium–10.8 percent yttrium alloy, in order to increase its ductility while maintaining high strength. It was found that the highest strengths could not be obtained without introducing cold work. The brittleness which accompanied the cold work could be removed by an anneal prior to aging. By use of the proper annealing treatment, satisfactory strength and ductility levels could be maintained. Annealing in the temperature range 750° to 805°F for one hour between cold working and aging gave higher strengths and ductilities than either solution-treated and aged or solution-treated, cold-worked and aged specimens. In particular, elongations of 8 to 10 percent with yield strengths of 45,000 psi and ultimate tensile strength of 55,000 psi, and yield strengths as high as 50 to 55,000 psi and ultimate tensile strengths as high as 60 to 65,000 psi, with elongations still in the range from 2 to 5 percent were obtained. (auth)

52305 (CONF-711001–(Vol.2), pp 657-67) GROWTH OF LARGE SINGLE CRYSTALS OF RARE-EARTH METAL ISOTOPES. Reed, R. E. (Oak Ridge National Lab., Tenn.). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

For neutron diffraction experiments on the magnetic structure of the rare earth metals, Sm, Dy, and Er, it is important to use large single crystal specimens of their low-neutron-capturing isotopes. A description is given of the techniques used to obtain large single crystals of the high-purity isotopes ^{154}Sm, ^{163}Dy, and ^{170}Er. Isotopic separation produced about 55 grams each of the required isotopes in the metal oxide form. The metal was produced by high-temperature reduction of the oxide, and cast into a button in a water-cooled copper mold using a high-purity arc melting facility. The total impurity content at this stage was <500 ppM by weight. The melt losses were about 50 mg for ^{163}Dy and ^{170}Er and 200 mg for ^{154}Sm. The buttons were sealed in argon-filled Ta cans, heated by induction, and annealed for 96 hours at 917, 1375, and 1450°C for the Sm, Dy, and Er, respectively. Any metal isotope lost from the button was recoverable from the Ta can interior. The resultant specimens had 5 to 8 single-crystal grains. The largest, obtained in the ^{163}Dy, was about 2.5 × 2.5 × 0.5 cm. All of the metal buttons had one or two grains large enough for neutron diffraction experiments. The substructure misorientation was <0.3 degrees as measured by neutron diffraction. (auth)

52306 (LA-tr–71-59) INHIBITION OF SINTERING DUE TO DEVELOPMENT OF GAS PRESSURE IN THE PORES. Francois, B.; Delmas, R.; Cizeron, G.; Kingery, W. D. Translated for Los Alamos Scientific Lab., N. Mex., from Mem. Sci. Rev. Met.; 64: 1079-94(1967). 38p. Dep. NTIS.

The kinetics of sintering and the microstructure of the products obtained were studied under operating conditions such that, during sintering, a gaseous phase is produced in the specimens consisting of immobile, small-sized crystals after the pores are closed. Similar observations were made in the two cases of uranium dioxide and tungsten. An abrupt halt of densification was observed which was linked to the appearance of a particular microstructure, in which the pores are situated at the grain boundaries, evolved at the onset of the temperature plateau at 1,600°C. The density and microstructure thus obtained are stable, even after annealing at higher temperatures. Analysis reveals the presence of gas in the pores. A simultaneous grain and pore growth occurs during isothermal sintering; it is temporary in the case of uranium dioxide. If, following mechanical abrasion of the gastight surface portion of the specimen, the pore network is placed in contact with the atmosphere of the furnace grain growth virtually ceases. (auth)

52307 PURIFICATION OF EUROPIUM. **Busch, G.; Kaldis, E.; Muheim, J.; Bischof, R. (Laboratorium fuer Festkoerperphysik, Zurich). J. Less-Common Metals; 24: No. 4, 453-7 (Aug 1971).**

The purification of europium has been carried out by ultrahigh vacuum distillation of the metal in a quartz apparatus. The purity was determined by mass-spectrometric analysis. The total content of the impurities (including gases) was found to be 170 at. ppM. Hydrogen (140 ppM), C (2.0 ppM), O (5.0 ppM), Ca (6.0 ppM) and Ba (4.0 ppM) were present. (auth)

52308 GROWTH OF SPHERICAL CRYSTALS OF INDIUM WITH RESPECT TO CRYSTAL GROWTH IN SPACE. **Walter, H. U.; Snyder, R. S. (Marshall Space Flight Center, Huntsville, Ala.). J. Less-Common Metals; 24: No. 4, 467-9(Aug 1971).**

The earth's gravitational field has an adverse effect on the perfection and size of melt-grown crystals. Because of the importance of more perfect and larger single crystals, the growth of such crystals in space is being planned. A method is described which can be used to grow spherical single crystals using adhesion and cohesion to suspend and position a containerless melt. The method was developed and verified using indium to grow crystals in air and high vacuum. (J.R.D.)

52309 PREPARATION OF THE LARGE TANTALUM SINGLE CRYSTALS WITH THE DESIRED ORIENTATION BY THE ELECTRON BEAM ZONE-MELT USING A TRANSVERSE HEARTH. **Tsubakitani, Hirofumi; Aono, Kiyoshi; Dohi, Shoso (Defence Academy, Yokosuka, Japan). Boei Daigakko Rikogaku Kenkyu Hokoku; 8: No. 1, 47-54(Jun 1970). (In Japanese).**

The process of growing large tantalum crystals by electron beam zone melting using a transverse hearth was investigated. A method of producing large single crystals and controlling crystal orientation was devised. Several slices with the same orientation were cut from a single crystal with the suitable orientation in a tantalum rod prepared by electron beam zone melting using the transverse hearth. After these slices were placed side by side on the bottom of the hearth so as to bring their proper orientation to parallel to the transverse direction of the hearth, they were covered with tantalum granules or blocks. In this way the electron beam zone-melt was used to produce large single crystals which have both the total length of the slices and the desired orientation. If more perfect and homogeneous crystal structure is required in the large single crystal, repetition of the zone-melt from both sides of the single crystal specimen is effective. (auth) (Japan)

52310 IRON MAKING WITH NUCLEAR ENERGY. **Segawa, Kiyosi (Nippon Steel Corp., Kawasaki, Japan). Taika Zairyo; No. 112, 7-15(Oct 1970). (In Japanese).**

The use of nuclear energy in iron production has attracted world interest in recent years. Background for the interest in the use of nuclear energy in iron making is reviewed including the technological revolution in iron making, the change in energy-supply situation, the development of nuclear reactors, advances in the direct reduction techniques of iron making, and progress of gas production methods. Aspects favoring the utilization of nuclear energy include inexpensive electricity in large quantities and direct use of high-temperature helium gas from HTGCR's for reduction. Models of the practical process and problems in realization of the process, and recent situations in Japan and foreign countries are presented. (Japan)

52311 INDUSTRIAL PRODUCTION OF SINTERED ELECTRODE STRIP. **Babaritskii, K. A.; Gaiduchenko, A. K.; Popichenko, E. Ya.; Katrus, O. A. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 1, 75-7 (Jan 1971).**

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 1, 95-7(Jan 1971).

A manufacturing process used in production of sintered electrode strips is described in which the product has density of 5.6 g/cm^3 with minimum tensile strength of 6 kg/mm^2. The strips are iron-based with various combinations of C, Mn, Si, Cr, V, and W additions. (J.R.D.)

52312 ADHESION PROPERTIES OF PLASMA-DEPOSITED TWO-METAL FILMS ON CERAMICS. **Bytin, L. L.; Shirokov, V. I. (Gorky Agricultural Inst., USSR). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 1, 69-72(Jan 1971).**

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 1, 88-92(Jan 1971).

Results are presented to show that films produced on ceramics by the technique of plasma spraying of mixed copper–titanium and copper–zirconium powders in air have the structure of a mechanical mixture of metals and oxides. The addition of titanium or tin powder to the original copper powder increases the adhesion of plasma-sprayed films to ceramics. (auth)

52313 SINTERED MATERIALS AND COMPONENTS. MANUFACTURE AND PROPERTIES OF POROUS TITANIUM–MOLYBDENUM ALLOY MATERIALS. **Arensburger, D. S.; Pugin, V. S.; Fedorchenko, I. M. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 9: No. 12, 986-9(Dec 1970).**

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 12, 39-42(Dec 1970).

A study is reported of the preparation and properties of porous permeable Ti–Mo alloy materials intended for operation in hot solutions of nonoxidizing acids. Comminution of both presintered rolled strips and sintered cakes of the alloys was studied as possible preparation methods. The process of diffusion impregnation of porous permeable Ti powder with Mo is recommended to yield the desired corrosion resistance. (B.L.M.)

52314 THEORY AND TECHNOLOGY OF SINTERING, THERMAL, AND CHEMICOTHERMAL TREATMENT PROCESSES. AUTOMATIC MEASUREMENT OF SHRINKAGE DURING SINTERING. **Vydrevich, L. A. Sov. Powder Met. Metal Ceram. (Engl. Transl.); 9: No. 12, 980-5(Dec 1970).**

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 12, 31-8(Dec 1970).

Descriptions are given of the designs of two devices for sintering shrinkage measurements for use in investigations into the shrinkage kinetics of materials based on refractory metals. The operation of the devices is based on the dilatometric principle with mechanical and electrical compensation for thermal expansion. Differential inductive coils are used as elements measuring changes in shrinkage during sintering and converting them into electrical signals. The gages can be used in conjunction with furnaces of all types at temperatures up to 3000°K with an error of ~2%. Using these devices an investigation of the shrinkage kinetics of W with small additions of Ni was carried out. (B.L.M.)

52315 PROCESS OF FINISHING PARTS OF ZIRCONIUM ALLOYS SUCH AS FOR USE WITH NUCLEAR REACTOR PLANTS. **Schweigert, Friedrich; Bertholdt, Horst (to Siemens Aktiengesellschaft). U. S. Patent 3,578,573. 11 May 1971. Priority date 10 May 1967, Germany.**

Finished parts of zirconium alloys, such as cladding tubes for nuclear fuels, are surface treated by electrolytic polishing. Preferably used is a polishing bath composed of acetic acid of about 99 to 100% concentration, perchloric acid of 40% concentration, and hydrochloric acid of 37% concentration in a mixing ratio of about 300 : 1 to 10 : 10 to 40 parts. A current density of ~20 to 150 A/dm^2 is used for the polishing at a temperature of 25°C. (Official Gazette)

52316 TREATMENT OF ZIRCONIUM AND ITS ALLOYS BY CHEMICAL DISPLACEMENT. **Brossa, Francesco; Ferrari, Giovanni; Musso, Giuseppe (to EURATOM). British Patent 1,239,863. 21 Jul 1971. Priority date 13 May 1968, Italy.**

Surfaces of Zr and its alloys can be treated by chemical displacement by being pickled and then immersed in a molten bath of $CuCl_2$ at a temperature between 430° and 600°C for 10 sec to 20 min to obtain a Cu deposit on the substrate. Immersion of the work piece in a LiCl–KCl eutectic at 500°C for 8 to 10 sec serves to remove a chloride coating left from the $CuCl_2$ bath. This process can be employed as a preparation for plating. (B.L.M.)

52317 DEVELOPMENT OF AN ULTRAFINE GRAIN SIZE TYPE-316 STAINLESS-STEEL CLADDING. **Reimann, G. A. (Oak Ridge National Lab., Tenn.). Nucl. Technol.; 10: No. 1, 62-6(Jan 1971).**

An ultrafine grain size of ASTM 14 with a dispersed carbide precipitate having a density of 10^{13} particles/cm^3 has been obtained in type 316 stainless steel tubing by repetitive cold working and low-temperature anneals. Such ultrafine grain sizes are unobtainable by using conventional techniques because of the inability to work tubing to large magnitudes without introducing flaws. The fine grain size and dispersed carbides may be a structure that is more resistant to irradiation-induced swelling and embrittlement

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than conventionally produced tubing. The process may be incorporated into commercial tube drawing practice with little difficulty. (auth)

Properties Evaluations

Refer also to abstracts 51734, 52961, and 52962.

52318 (ANL-7820) CHEMICAL ENGINEERING DIVISION REACTOR SAFETY AND PHYSICAL PROPERTY STUDIES SEMI-ANNUAL REPORT, JANUARY–JUNE 1971. Chasanov, M. G.; Fischer, J.; Fredrickson, D. R.; Gabelnick, S. D.; Leibowitz, L.; Tevebaugh, A. D.; Vogel, R. C. (Argonne National Lab., Ill.). Jul 1971. Contract W-31-109-eng-38. 18p. Dep. NTIS.

A report of the work on reactor safety and physical properties studies is given for the period January through June 1971. Calorimetric studies include measurement of the enthalpy of Na_3UO_4 from 600 to about 1200°K and of $(U_{0.8}Pu_{0.2})O_{1.97}$ from 2348 to 3041°K. Partial infrared spectra for uranium oxide species in the region 1000 to 600 cm^{-1} have been obtained by matrix isolation spectroscopy. Work is in progress on the determination of the speed of sound in sodium from 1270 to 1800°K. Calculation of fission-product and fuel vapor pressures at high temperatures (~6000°K) based on extrapolation of available thermodynamic data is nearing completion. The electron-beam furnace to be used in determining the thermal diffusivity of molten UO_2 is being tested after completing required modifications of the furnace. Studies of the distribution of Zr, Ce, La, Y, Mo, and Ru between molten UO_2 and iron have been completed. (auth)

52319 (CONF-710712-3) ALLOY CHEMISTRY OF RARE-EARTH AND ACTINIDE ELEMENTS. Nevitt, Michael V. (Argonne National Lab., Ill.). [1971]. 5p. Dep. NTIS.

From Conference on rare earths and actinides; Durham, U. K. (5 Jul 1971).

A summary comparison of the alloy chemistry of lanthanide and actinide metals is presented. The treatment is largely descriptive and is limited to consideration of the occurrence of certain isostructural intermediate phases in binary systems having as one component a metal of the series lanthanum through lutetium, denoted Ln, or a metal from the series actinium through lawrencium, designated An. The other component, X, is a transition metal from the first, second, or third long period or an element from Groups 1B through VIB. (auth)

52320 (CONF-711001-(Vol.1), pp 386-96) THERMAL CONDUCTIVITY OF CERIUM AT HIGH TEMPERATURE. Wittenberg, Layton J. (Mound Lab., Miamisburg, Ohio). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The thermal conductivity of cerium was measured from 500 to 900°C by use of a transient thermal diffusivity technique. The thermal conductivity remained nearly constant throughout the fcc and bcc solid phases at approximately 0.098 W/cm-deg and decreased to 0.075 W/cm-deg in the liquid. When these measurements were compared with electrical resistivity measurements the Lorentz number was only one-half its normal value. Both thermal and electrical conductivity measurements agree that no change in the electronic configuration of the metallic atom was detectable at the melting point. (auth)

52321 (CONF-711001-(Vol.2), pp 795-803) DISSOCIATION ENERGIES OF SCANDIUM AND YTTRIUM MONOAURIDES AND PREDICTED STABILITIES OF SELECTED DIATOMIC INTERMETALLIC COMPOUNDS WITH SCANDIUM AND YTTRIUM. Gingerich, K. A.; Finkbeiner, H. C. (Texas Agricultural and Mechanical Univ., College Station. Dept. of Chemistry). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The third-law enthalpies of several exchange reactions involving the molecules ScAu and YAu have been measured by means of Knudsen-cell mass spectrometry. Combination of the resulting enthalpies with appropriate literature data yielded the following dissociation energies: D_0^0(ScAu) = 66.1 ± 4.0 kcal mol^{-1} and D_0^0(YAu) = 71.1 ± 4.0 kcal mol^{-1}. These values are in good agreement with those previously predicted using the Pauling model of a polar bond. This model was applied to calculate the bond energies of selected diatomic intermetallic scandium and yttrium compounds. (auth)

52322 (COO-916-24) SERRATED YIELDING IN SINGLE CRYSTALS OF SILVER–INDIUM ALLOYS. Technical Progress Report. Johnson, J. D.; Hendrickson, A. A. (Michigan Technological Univ., Houghton. Dept. of Metallurgical Engineering). [1971]. Contract AT(11-1)-916. 17p. Dep. NTIS.

Serrated yielding was observed in tensile tests of high purity single crystals of Ag-9.6 at. % In. The temperature dependence of the critical strain for the onset of serrations was measured. The estimated apparent activation energy is 0.6 to 1.0 eV. Techniques of preparing high purity and relatively strain free Ag–In single crystals of a selected orientation are discussed. (auth)

52323 (COO-1198-834) INTERNAL FRICTION IN THE NIOBIUM–HYDROGEN SYSTEM. Baker, Craig Carlton (Illinois Univ., Urbana). Jun 1971. Contract AT(11-1)-1198. 109p. Dep. NTIS.

Thesis.

The diffusional behavior of hydrogen in niobium was investigated in the temperature range 20 to 273°K using internal friction techniques. Relaxations due to two types of hydrogen complexes were observed: hydrogen pairs, and oxygen (or nitrogen)–hydrogen pairs. The hydrogen pair was shown to have an enthalpy of motion of 1265 cal/mole and an enthalpy of binding of 1490 cal/mole. The oxygen (or nitrogen)–hydrogen pair was shown to consist of a single hydrogen atom bound to the oxygen interstitial with an enthalpy of about 2000 cal/mole. The hydrogen motion enthalpy in the strain field of the oxygen atom was 3800 cal/mole. The cold work damping peak due to hydrogen moving in the strain field of a dislocation was observed and interpreted. A dislocation-hydrogen binding enthalpy of about 7300 cal/mole was determined. The solvus line for the Nb–H system was studied using the internal friction techniques and it was shown that good agreement was obtained with the higher temperature phase diagram solubility. The present techniques allow the solvus line to be determined at very low temperatures. A variation of the enthalpy of solution of the hydride with temperature was noted and studied. (auth)

52324 (COO-1436-30) DIFFUSION IN TERNARY SILVER–ZINC–CADMIUM SOLID SOLUTIONS. Carlson, P. T.; Dayananda, M. A.; Grace, R. E. (Purdue Univ., Lafayette, Ind.). 14 Jun 1971. 41p. Dep. NTIS.

Thesis. Submitted by P. T. Carlson.

Diffusion in the silver-zinc-cadmium system was investigated at 600°C with semi-infinite, vapor-solid couples in order to evaluate intrinsic diffusion coefficients and interdiffusion coefficients in the alpha and beta phases. Intrinsic diffusion coefficients were determined at several composition points in the alpha phase region along concentration lines of 11 at.% Zn, 18 at.% Zn, 5 at.% Cd and 9 at.% Cd. Interdiffusion coefficients in the α phase were determined at several points of intersection of various composition paths; these composition points of intersection were along lines of constant zinc-to-cadmium concentration ratios of 3.8, 1.8, and 1.2. All two-phase diffusion couples developed planar β/α interfaces. Intrinsic coefficients were computed at three composition points in the beta region corresponding to a silver concentration of approximately 55 at.%. Intrinsic coefficients for β alloys are two to three orders of magnitude larger than those for alpha alloys. (auth)

52325 TEXTURE COEFFICIENT IN THE CHARACTERIZATION OF Zr ALLOYS TUBES: SOME EXPERIMENTAL DETERMINATIONS. Beghi, G.; Cazzaniga, E. (CCR-EURATOM, Ispra, Italy). Energ. Nucl. (Milan); 18: No. 6, 346-52(Jun 1971). (In Italian).

The behavior of zirconium alloys is often correlated with preferred orientations in the matrix. Quantitative determinations of these orientations are reported for two Zr-2.5% Nb tubes, fabricated using different fabrication schedules and for a Zircaloy 2 tube. The method is that of texture coefficient and inverse pole figure, as developed by different workers. (auth)

52326 THERMOPHYSICAL PROPERTIES OF TANTALUM, TUNGSTEN, AND TANTALUM–10 WT. PER CENT TUNGSTEN AT HIGH TEMPERATURES. Taylor, R. E.; Kimbrough, W. D.; Powell, R. W. (Purdue Univ., Lafayette, Ind.). J. Less-Common Metals; 24: No. 4, 369-82(Aug 1971).

A high-temperature multi-property apparatus is briefly described. Experimental data covering the range from about 1400 to 2800°K are presented for one sample of tantalum, three samples of tungsten, and two samples of tantalum–10 wt % tungsten alloy. The tungsten samples were from a batch used in a high-temperature thermal conductivity reference standards program and the tantalum-10 tungsten alloy has been incorporated in an international round-robin study. Properties measured were thermal conductivity, electrical resistivity, normal spectral emittance at 0.65 μm, hemispherical total emittance, Weidemann–Franz–Lorenz ratio, and Thomson coefficient. (auth)

52327 MECHANICAL PROPERTIES OF TUNGSTEN–23.4 PERCENT RHENIUM–0.27 PERCENT HAFNIUM–CARBON ALLOY. Klopp, W. D.; Witzke, W. R. (Lewis Research Center, Cleveland). J. Less-Common Metals; 24: No. 4, 427-43(Aug 1971).

A study was conducted to determine if particle strengthening by a HfC precipitate could be obtained in a ductile W–high Re alloy. A W–23.4 Re–0.27 Hf–C alloy was consolidated by arc melting, fabricated to sheet and rod, and evaluated by tensile, creep, and bend testing. The carbon content of test specimens ranged from 0.12 to 1.12 at. %. The alloy was found to exhibit good high temperature strength properties. For example, at 3000°C, the HfC-strengthened alloy had a short-time tensile strength of 62.7 ksi, more than double the strength of 28.1 ksi observed earlier for W–24 Re. The strength advantage decreases at higher temperatures due to rapid HfC particle coarsening and grain boundary sliding. The alloy exhibited good tensile and bend ductility at room temperature. It is concluded that the W–high Re alloy with a fine HfC precipitate has an attractive combination of low temperature ductility and high strength to temperatures of about 3000°F. (auth)

52328 STABILITY AND PLASTICITY OF YTTRIUM. Gladkikh, A. N. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk; No. 5, 115-19(1970). (In Russian).

Yttrium metal cylinders of 99.2% purity were subjected to compression-type deformation tests over a range of temperatures from 95 to 796°C. All three carefully defined plasticity characteristics are increased by a rise in temperature; the two stability characteristics are decreased. (K.S.W.)

52329 STANDARD SPECIFICATION FOR TANTALUM AND TANTALUM ALLOY TUBING. ASTM B521-70. Philadelphia; American Society for Testing and Materials (1970). 5p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers tantalum and tantalum alloy tubing of the following types: Alloy 400—unalloyed tantalum, and Alloy 401—tantalum-10 percent tungsten. (auth)

52330 STANDARD SPECIFICATION FOR QUENCHED AND TEMPERED CARBON AND ALLOY STEEL FORGINGS FOR PRESSURE VESSEL COMPONENTS. ASTM A541-69. Philadelphia; American Society for Testing and Materials (1969). 8p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers requirements for quenched and tempered carbon and alloy steel forgings for pressure vessel components. Eight classes of steel are covered. The maximum section thickness for forgings of the various classes is limited by the ability of the selected composition to respond to the heat treatment and meet the specified mechanical tests. The maximum section thickness to which the various classes can normally be furnished is listed. All classes are considered weldable under proper conditions. Welding technique is of fundamental importance, and it is presupposed that welding procedure and inspection will be in accordance with approved methods for the class of material used. (auth)

52331 STANDARD SPECIFICATION FOR HIGH-STRENGTH ALLOY STEEL PLATES, QUENCHED AND TEMPERED, FOR PRESSURE VESSELS. ASTM A517-70. Philadelphia; American Society for Testing and Materials (1970). 7p. Available from American Society for Testing and Materials, Philadelphia).

This specification covers high-strength quenched and tempered alloy steel plates intended for use in fusion-welded boilers and other pressure vessels. The maximum thickness of plates to be specified under this specification shall be $1\frac{1}{4}$ in. for Grades A, B, C, D, and J, 2 in. for Grades G, H, K, L, and M, and $2\frac{1}{2}$ in. for Grades E, F and P. Welding technique is of fundamental importance and must be such as to not adversely affect the properties of the plate, especially in the heat affected zone. It is presupposed that welding procedures will be suitable for the materials being welded. (auth)

52332 STANDARD SPECIFICATION FOR EIGHT AND NINE PER CENT NICKEL ALLOY STEEL PLATE, QUENCHED AND TEMPERED, FOR PRESSURE VESSELS. ASTM A553-71. Philadelphia; American Society for Testing and Materials (1971). 6p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers water quenched and tempered 8 and 9 percent nickel alloy steel plate for use in pressure vessels. This specification includes two types of steel, Type A and Type B. The maximum thickness of plates is limited only by the capacity of the composition to meet the specified mechanical property requirements; however, current practice normally limits the thickness of plates furnished under this specification to 2 in. maximum. This material is intended primarily for fusion welding. (auth)

52333 STANDARD SPECIFICATION FOR NICKEL–COBALT–MOLYBDENUM–CHROMIUM ALLOY STEEL PLATES, QUENCHED AND TEMPERED, FOR PRESSURE VESSELS. ASTM A605-70. Philadelphia; American Society for Testing and Materials (1970). 3p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers a class of 9 percent nickel, 4 percent cobalt, molybdenum–chromium alloy steel plates at an ultimate tensile strength level of 190 to 220 ksi for use in the quenched and tempered condition, and intended for the construction of pressure vessels and other pressure equipment. Construction involving fusion welding is intended and welding technique is of fundamental importance. The minimum thickness of plates to be furnished to this specification is $\frac{3}{16}$ in. and the maximum thickness is 6 in. Supplementary requirements are provided for use when additional testing or inspection is desired. These shall apply only when specified individually by the purchaser in the order. (auth)

52334 STANDARD SPECIFICATION FOR CHROMIUM–MOLYBDENUM ALLOY STEEL PLATES, QUENCHED AND TEMPERED, FOR PRESSURE VESSELS. ASTM A542-70. Philadelphia; American Society for Testing and Materials (1970). 5p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers three classes of chromium-molybdenum steel plates for use in the quenched and tempered condition, intended for the fabrication of pressure vessels and other pressure equipment. Fabrication involving fusion welding is intended and welding technique is of fundamental importance. It is presupposed that welding procedures will be qualified in accordance with the applicable fabrication code requirements. The minimum thickness of plates to be furnished to this specification is $\frac{3}{16}$ in. The maximum thickness is limited only by the capacity of the specified composition to respond to heat treatment and meet specified mechanical tests. Supplementary requirements are provided for use when additional testing or inspection is desired. These shall apply only when specified individually by the purchaser in the order. (auth)

52335 STANDARD SPECIFICATION FOR SUPPLEMENTARY REQUIREMENTS FOR NICKEL ALLOY PLATE FOR NUCLEAR APPLICATIONS. ASTM B509-70. Philadelphia; American Society for Testing and Materials (1970). 2p. Available from American Society for Testing and Materials, Philadelphia.

This specification provides supplementary requirements for nickel-copper alloy, nickel-chromium-iron alloy, and nickel-iron–chromium alloy plate for nuclear applications. It is intended to be used in conjunction with a basic production specification. This specification applies to plate $\frac{3}{4}$ in. and over in thickness. (auth)

52336 STANDARD SPECIFICATION FOR STAINLESS AND HEAT-RESISTING STEEL BARS AND SHAPES FOR USE IN BOILERS AND OTHER PRESSURE VESSELS. ASTM A479-63. Philadelphia; American Society for Testing and Materials (1963). 9p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers hot-finished bars and cold-finished bars of stainless and heat-resisting steel, including rounds, squares, and hexagons, and hot-rolled or extruded shapes such as angles, tees, and channels for use in boiler and pressure vessel construction. (auth)

52337 STANDARD SPECIFICATION FOR QUENCHED AND TEMPERED VACUUM TREATED CARBON AND ALLOY STEEL FORGINGS FOR PRESSURE VESSELS. ASTM A508-69. Philadelphia; American Society for Testing and Materials (1969). 9p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers quenched and tempered vacuum treated carbon and alloy steel forgings for pressure vessels such as those used in reactor systems. Specifically, it covers forgings for vessel closures, shells, flanges, tube sheets, rings, heads, and similar parts. All classes are considered weldable under proper conditions. Welding technique is of fundamental importance, and it is presupposed that welding procedure and inspection will be in accordance with approved methods for the class of material used. (auth)

52338 STANDARD SPECIFICATION FOR TITANIUM AND TITANIUM-ALLOY CASTINGS. ASTM B367-69. Philadelphia; American Society for Testing and Materials (1969). 4p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers ten grades of unalloyed titanium and titanium alloy castings as follows: Grades C-1 to C-4–unalloyed

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titanium; Grade C-5–Ti-6Al-4V; Grade C-6–Ti-5Al-2.5 Sn; and Grades C-7A, C-7B, C-8A, C-8B are Ti-Pd. (auth)

52339 VOLUME INTERDIFFUSION IN THE MOLYBDENUM–TUNGSTEN SYSTEM. Erley, W.; Wagner, H. (Kernforschungsanlage, Juelich, Ger.). Phys. Status Solidi (a); 6: No. 2, 543-50 (16 Aug 1971).

Molybdenum/tungsten single-crystal diffusion couples were prepared by pressure bonding and were successively diffusion annealed at 1900, 2045, 2150, and 2250°C, each for 100 hr. Concentration–distance profiles were determined by electron-microprobe analysis using an empirical relationship between relative x-ray intensity and concentration. The Boltzmann–Matano analysis was used for determining the chemical diffusion coefficient D. The latter can be described by the following expression: $D(C_{Mo}) = 0.11 \exp(3.45\ C_{Mo}) \exp(-126\ 000/RT)$. Inserting this expression into Fick's second law and choosing a reduced variable ξ, being a function of distance, diffusion time, and annealing temperature, an ordinary differential equation is obtained. A graph of the numerical solution of this equation is given, which allows an easy determination of concentration–distance profiles for any given diffusion time and temperature. (auth)

52340 ZENER RELAXATION IN SILVER–CADMIUM AND SILVER–INDIUM SOLID SOLUTIONS. Mills, B. (Univ. of Salford, Eng.). Phys. Status Solidi (a); 6: No. 1, 55-61(16 Jul 1971).

The Zener relaxation was studied in a number of alloys of the silver–cadmium and silver–indium systems. The temperature dependence of the relaxation time (τ_r) for four alloys is described by the equations: Ag–29 at. % Cd $\tau_r = 10^{-15} \exp(36400/RT)$ sec, Ag–39 at. % Cd $\tau_r = 10^{-13.28} \exp(29400/RT)$ sec, Ag–7.5 at. % In $\tau_r = 10^{-14.5} \exp(38000/RT)$ sec, Ag–15.6 at. % In $\tau_r = 10^{-14.1} \exp(31800/RT)$ sec. The present work on silver–indium alloys suggests that the relaxation is controlled by diffusion of silver at low concentrations of indium, while at high indium concentrations the relaxation may be controlled by diffusion of indium. In addition to measurements described by the above equations the relaxation strength, Δ_m, of Ag–3.65 at. % In and Ag–18.95 at. % In alloys was measured. The composition dependence of Δ_m did not obey a $c^2(1-c)^2$ relation; it is suggested that a change in the rate-controlling process of the relaxation at high indium concentrations accounts for this behavior. For the Ag–39 at. % Cd alloy, a large difference between the relaxation and diffusion activation energies of either species in the alloy was measured. (auth)

52341 STANDARD SPECIFICATION FOR PIPING FITTINGS OF WROUGHT CARBON STEEL AND ALLOY STEEL FOR MODERATE AND ELEVATED TEMPERATURES. ASTM A234-71. Philadelphia; American Society for Testing and Materials (1971). 6p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers wrought carbon steel and alloy steel fittings of seamless and welded construction for use in pressure piping and in pressure vessel fabrication for service at moderate and elevated temperatures. The term fitting applies to butt-welding, socket-end, and threaded-end parts such as 45 and 90° elbows, 180° return bends, caps, tee, reducers, lap-joint stub ends, and other types as covered by the latest revision of ANSI B16.9, MSS SP48, and ANSI B16.11. Optional supplementary requirements are provided for fittings where a greater degree of examination is desired. When desired, one or more of these supplementary requirements may be specified in the order. This specification does not cover cast welding fittings. (auth)

52342 STANDARD SPECIFICATION FOR STAINLESS AND HEAT-RESISTING STEEL BARS, AND SHAPES. ASTM A276-70. Philadelphia; American Society for Testing and Materials (1970). 7p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers hot-finished or cold-finished bars except bars for reforging, including rounds, squares, and hexagons, and hot-rolled or extruded shapes, such as angles, tees, and channels in the more commonly used types of stainless steels, excluding the free-machining types, for general corrosion resistance and high-temperature service. (auth)

52343 STANDARD SPECIFICATION FOR SEAMLESS FERRITIC ALLOY STEEL PIPE FOR HIGH-TEMPERATURE SERVICE. ASTM A335-70. Philadelphia; American Society for Testing and Materials (1970). 9p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers nominal (average) wall seamless alloy-steel pipe intended for high-temperature service. Pipe ordered to this specification shall be suitable for bending, flanging (vanstoning), and similar forming operations, and for fusion welding. Selection will depend upon design, service conditions, mechanical properties, and high-temperature characteristics. Several grades of ferritic steels are covered. Supplementary requirements (S1 to S6) of an optional nature are provided. These supplementary requirements call for additional tests to be made, and when desired shall be so stated in the order, together with the number of such tests required. (auth)

52344 STANDARD SPECIFICATION FOR CHROMIUM–MOLYBDENUM ALLOY STEEL PLATES FOR PRESSURE VESSELS. ASTM A387-70a. Philadelphia; American Society for Testing and Materials (1970). 7p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers two groups of chromium–molybdenum steel plates of five compositions intended for use in boilers and other pressure vessels designed for elevated temperature service. Group I is composed of three grades, containing not more than 1.5 per cent chromium and designated A, B, and C. Group II consists of two grades, containing between 2 per cent and 3¼ per cent chromium and designated D and E, intended for mildly corrosive service as well as for elevated temperature service. The maximum thickness of plates of Group I and Group II is limited only by the ability of the selected composition to meet the mechanical tests. Welding technique is of fundamental importance and it is presupposed that welding procedures will be in accordance with an approved method for these grades of materials. Supplementary requirements are provided for use when additional testing or inspection is desired. These shall apply only when specified individually by the purchaser in the order. (auth)

52345 STANDARD SPECIFICATION FOR STAINLESS AND HEAT-RESISTING STEEL FORGINGS. ASTM A473-70. Philadelphia; American Society for Testing and Materials (1970). 7p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers austenitic, ferritic, and martensitic stainless and heat-resisting steel forgings for general use, and for low, or high temperature service. (auth)

52346 STANDARD SPECIFICATION FOR MANGANESE–MOLYBDENUM AND MANGANESE–MOLYBDENUM–NICKEL ALLOY STEEL PLATES, QUENCHED AND TEMPERED, FOR PRESSURE VESSELS. ASTM A533-70. Philadelphia; American Society for Testing and Materials (1970). 6p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers four grades of manganese–molybdenum and manganese–molybdenum–nickel alloy steel plates for use in the quenched and tempered condition and intended for the construction of pressure vessels and other pressure equipment. Construction involving fusion welding is intended and welding technique is of fundamental importance. It is presupposed that welding procedures will be qualified in accordance with the applicable fabrication code requirements. The minimum thickness of plates to be furnished to this specification is ¼ in. The maximum thickness of Classes 1 and 2 is limited only by the capacity of the selected composition to respond to the heat treatment and meet the specified mechanical tests. The maximum thickness of Class 3 is limited to 2 in. (auth)

52347 STANDARD SPECIFICATION FOR CARBON-STEEL CASTINGS SUITABLE FOR FUSION WELDING FOR HIGH-TEMPERATURE SERVICE. ASTM A216-70a. Philadelphia; American Society for Testing and Materials (1970). 6p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers carbon steel castings for valves, flanges, fittings, or other pressure containing parts for high-temperature service and of quality suitable for assembly with other castings or wrought-steel parts by fusion welding. Three grades, WCA, WCB, and WCC, are covered in this specification. Selection will depend upon design and service conditions, mechanical properties, and the high-temperature characteristics. (auth)

52348 STANDARD SPECIFICATION FOR ALLOY STEEL BOLTING MATERIALS FOR LOW-TEMPERATURE SERVICE. ASTM A320-70. Philadelphia; American Society for Testing and Materials (1970). 9p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers alloy steel bolting materials for pressure vessels, valves, flanges, and fittings for low-temperature service. Bolting material covers rolled, forged, or strain hardened bars, bolts, screws, studs, and stud bolts. Ten grades are covered, including both ferritic and austenitic steels designated L7, B8. Selection will depend on design, service conditions, mechanical properties, and low-temperature characteristics.

Nuts and washers for use with this bolting material are discussed. Supplementary Requirement S1 of an optional nature is provided. It shall apply only when specified in the inquiry, contract and order. (auth)

52349 STANDARD SPECIFICATION FOR SUPPLEMENTARY REQUIREMENTS FOR NICKEL ALLOY SEAMLESS PIPE AND TUBE FOR NUCLEAR APPLICATIONS. ASTM B513-70. Philadelphia; American Society for Testing and Materials (1970). 3p. Available from American Society for Testing and Materials, Philadelphia.

This specification provides supplementary requirements for nickel–copper alloy, nickel–chromium–iron alloy, and nickel–iron–chromium alloy seamless pipe and tube for nuclear applications. It is intended to be used in conjunction with a basic production specification. This specification applies to cold-drawn pipe and tube in sizes of $6\frac{5}{8}$ in. and under in outside diameter and hot-finished tube in sizes of $9\frac{1}{4}$ in. and under in outside diameter. Three types of nondestructive testing requirements are covered and the purchase order should state which is to apply. (auth)

52350 STANDARD SPECIFICATION FOR SUPPLEMENTARY REQUIREMENTS FOR NICKEL ALLOY ROD AND BAR FOR NUCLEAR APPLICATIONS. ASTM B510-70. Philadelphia; American Society for Testing and Materials (1970). 2p. Available from American Society for Testing and Materials, Philadelphia.

This specification provides supplementary requirements for nickel–copper alloy, nickel–chromium–iron alloy, and nickel–iron–chromium alloy rod and bar for nuclear applications. It is intended to be used in conjunction with a basic production specification. Two nondestructive testing options are covered and the purchase order should state which is to apply. (auth)

52351 AMERICAN NATIONAL STANDARD CLASSIFICATION OF UNIRRADIATED URANIUM SCRAP. ANSI N15.1 1970. New York; American National Standards Institute, Inc. (1970). 15p. Available from American National Standards Institute, New York.

This standard of classifications applies to the area of cold uranium scrap. The purpose of this standard is to provide a classification system with inherent flexibility which will provide a means for facilitating activities in the nuclear industry relevant to the classifications set forth in this standard. (auth)

52352 NATURE OF THE CHEMISORPTION PHASES. Ustinov, Yu. K. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: No. 11, 1912-13(May 1971).

Translated from Zh. Tekh. Fiz.; 40: No. 11, 2447-9(Nov 1970).

The results of experimental flash-method studies of the chemisorption of simple gases (H_2, CO, N_2, and O_2) on tungsten are discussed on the basis of a model of interacting adsorbed particles. The oscillatory nature of the indirect interaction of adsorbed particles through adsorbent conduction electrons can be explained on the basis of the two phases observed during the chemisorption of these gases (the β_2 and β_1 phases during the flash desorption) and by several features of the replacement of one adsorbed gas by another. Several quantitative characteristics of the desorption (the compensating change of the pre-exponential factors as the activation energy changes, etc.) are also explained. (auth)

52353 INVESTIGATION OF OXYGEN ADSORPTION ON A MOLYBDENUM SURFACE BY MEANS OF SECONDARY ION–ION EMISSION. Kolot, V. Ya.; Tatus, V. I.; Rybalko, V. F.; Fogel, Ya. M. Sov. Phys.-Tech. Phys. (Engl. Transl.); 15: No. 11, 1934-6(May 1971).

Translated from Zh. Tekh. Fiz.; 40: No. 11, 2469-71(Nov 1970).

Investigations of O adsorption on Mo surfaces for O_2 pressures from 5×10^{-8} to 1×10^{-6} torr and for temperatures from 300° to 1900°K by secondary ion–ion emission indicate that adsorption of elemental O on the molybdenum surfaces and oxidation of the surfaces do not take place simultaneously. The elemental O adsorption deposit reaches a certain value (estimated to be of the order of $\frac{1}{10}$ of a monolayer) and remains essentially constant for ~1 min at a pressure of 5×10^{-8} torr for temperatures of 500° to 900°K, before the emission of secondary ions of Mo oxides signals the oxidation of Mo. Increasing O pressures decreased the latent period. (B.L.M.)

52354 THEORY, PRODUCTION, AND PROPERTIES OF POWDERS AND FIBERS. PHOTOSEDIMENTATION ANALYSIS OF POWDERS. Kiyanskii, I. A.; Borok, B. A.; Dzneladze, Zh. I. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 9: No. 11, 874-7(Nov 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 11, 5-9(Nov 1970).

A photosedimentation technique was found to be a very accurate method of determining the particle-size distribution of powders. Analytical accuracy depends to a large extent on the condition of the powder being tested and the composition of the dispersing medium. This technique was applied to the determination of particle-size distribution in powders of Mo and of a Nb–Ti–Zr alloys, and the results are presented. (B.L.M.)

52355 CREEP AND CREEP-RUPTURE PROPERTIES OF THE NUCLEAR FUEL CLADDING TUBE FOR FAST BREEDER REACTOR. Tanaka, Chiaki (National Research Inst. for Metals, Tokyo); Yoshida, Susumu; Yachita, Tuneaki; Nagasaki, Ryukichi; Yuhara, Shun-ichi. Zairyo; 20: No. 210, 387-94 (Mar 1971). (In Japanese).

For the design and fabrication of experimental fast breeder reactors it is desirable to obtain the creep and creep-rupture properties of Type 316 stainless steel tubes with 5.6 mm inside diameter and 0.35 mm wall thickness, that will contain nuclear fuel. The creep-rupture tests under internal gas pressure and creep and creep-rupture tests under uniaxial tension were carried out on two kinds of these tubes, one of which was approximately 6% cold-drawn and the other was approximately 18% cold-drawn, both unirradiated and tested under atmospheric conditions at temperatures of 550, 600, 650, and 700°C. It was found that the regression curves for the creep-rupture data obtained from the internal pressure tests and uniaxial tension tests showed points of bend at the pressure of 360 kg/cm^2 and stress of 30 kg/mm^2 when the Larson–Miller parameter method was applied. The data for uniaxial tension tests showed a little greater creep-rupture strength for 6% cold-drawn tubes and definitely greater creep-rupture strength for 18% cold-drawn tubes. The creep-rupture strength of 18% cold-drawn tubes is generally greater than that of 6% cold-drawn tubes. However, the creep-rupture curves for the two kinds of tubes tended to approach each other when the temperature was raised from 600 to 700°C and the test time was prolonged. The data for creep-rupture tests under internal pressure agreed with those for uniaxial tension tests at stresses less than 30 kg/mm^2, when the hoop stress of internally pressurized specimens was calculated by the mean diameter formula. (auth) (Japan)

52356 LOW-TEMPERATURE PLASTIC INSTABILITY IN PURE NIOBIUM SINGLE CRYSTALS. Kubin, L. P.; Jouffrey, B. (Faculte des Sciences, Orsay, France). Phil. Mag.; 24: No. 188, 437-49(Aug 1971).

Niobium single crystals of good purity and of various orientations were tested in tension between 2.17 and 17°K. At temperatures below about 12°K, heterogeneous deformation takes place. It seems possible to explain this behavior by the local heating due to moving dislocations. The thermal origin of this instability is deduced by comparing stress–strain curves performed at 2.17°K in the normal and superconductive states. The influence of purity and temperature on thermal softening is discussed. (UK)

52357 ACTIVATION ENERGY OF SURFACE SELF-MIGRATION OF TUNGSTEN IN THE PRESENCE OF A CARBON IMPURITY. Case, Clinton M. Reno, Nev.; Univ. of Nevada (1970). 79p. University Microfilms Order No. 71-19,929. Thesis.

The surface self-migration of tungsten atoms over their own lattice structure in the presence of small amounts of carbon on the tungsten surface was studied using pulsed-field electron-emission techniques. The activation energy of surface self-migration was found to increase by a factor of approximately two over the value for clean tungsten. In the course of the work four effects were observed which are not observed for clean tungsten emitters: (1) On heating the emitter, atomic lattice planes were observed to collapse in groups when carbon is on the surface. For clean tungsten such grouping was not observed. This is explained as being due to the existence of a multiple step height at the [110] lattice plane. (2) The average electron work function of the emitter was lowered from a value of 4.5 eV for clean tungsten to a value of about 2.4 eV in the presence of a relatively large surface coverage of carbon. Examination of the field emission patterns shows that most of the emission current comes from the regions surrounding the [110] and [211] planes and that the planes lying on the [100] zone lines, such as the [210], [310], and so on as well as the [111] and [334] planes, appear to have less current coming from them than when the surface is clean. (3) Distinct [334] planes appeared as dark "holes" on the field emission pattern. These planes were not developed on a clean tungsten emitter. They disappear on heating to a "critical" temperature which increases with increasing carbon coverage. The planes reappear on cooling slowly to temperatures below the critical temperature and grow in size as the temperature is further decreased. (4) Collapsing surface layers were observed on the

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[334] planes analogous to those observed on the [110] planes. This was unexpected in view of the atomically rough nature of the [334] region on the body-centered cubic crystal surface. (Diss. Abstr. Int., B)

52358 IMPURITY DIFFUSION IN CADMIUM. Mao, Chihwen. Troy, N. Y.; Rensselaer Polytechnic Inst. (1971). 153p. University Microfilms Order No. 71-19,886.

Thesis.

Diffusion of impurities in single crystals of cadmium was studied by tracer-sectioning techniques. For heterovalent diffusions the diffusion coefficients, in $\mathrm{cm}^2/\mathrm{sec}$, are given by:

$$
\begin{aligned}
D_{\parallel}\ (\mathrm{In}) &= \exp(-2.35 \pm 0.20)\ \exp(-(17.45 \pm 0.19)\ 1000/RT)\\
D_{\perp}\ (\mathrm{In}) &= \exp(-2.47 \pm 0.16)\ \exp(-(16.94 \pm 0.15)\ 1000/RT)\\
D_{\parallel}\ (\mathrm{Ag}) &= \exp(+0.28 \pm 0.47)\ \exp(-(24.64 \pm 0.48)\ 1000/RT)\\
D_{\perp}\ (\mathrm{Ag}) &= \exp(-0.45 \pm 0.62)\ \exp(-(25.07 \pm 0.65)\ 1000/RT)\\
D_{\parallel}\ (\mathrm{Au}) &= \exp(+0.28 \pm 0.08)\ \exp(-(25.47 \pm 0.08)\ 1000/RT)\\
D_{\perp}\ (\mathrm{Au}) &= \exp(+1.09 \pm 0.22)\ \exp(-(26.43 \pm 0.22)\ 1000/RT)
\end{aligned}
$$

The activation energies obtained in this study could be interpreted with LeClaire's version screening model. Excellent agreement between experimental results and theoretical estimation was obtained. For homovalent diffusions (including self-diffusion), the results are:

$$
\begin{aligned}
D_{\parallel}\ (\mathrm{Zn}) &= \exp(-21.0 \pm 0.26)\ \exp(-(18.03 \pm 0.25)\ 1000/RT)\\
D_{\perp}\ (\mathrm{Zn}) &= \exp(-2.54 \pm 0.24)\ \exp(-(18.02 \pm 0.24)\ 1000/RT)\\
D_{\parallel}\ (\mathrm{Cd}) &= \exp(-2.20 \pm 0.13)\ \exp(-(18.61 \pm 0.12)\ 1000/RT)\\
D_{\perp}\ (\mathrm{Cd}) &= \exp(-1.76 \pm 0.19)\ \exp(-(19.59 \pm 0.19)\ 1000/RT)\\
D_{\parallel}\ (\mathrm{Hg}) &= \exp(-1.61 \pm 0.07)\ \exp(-(18.78 \pm 0.06)\ 1000/RT)\\
D_{\perp}\ (\mathrm{Hg}) &= D_{\parallel}\ (\mathrm{Hg})
\end{aligned}
$$

It is felt that valence effect and size effect are competing in homovalent diffusion. The size effect appears dominant in the case of Cd as base metal as against the case of Zn as base metal where valence effect appears dominant. A preliminary study of the isotope effect of Zn in Cd was also conducted. The resulting values of E for diffusion parallel and perpendicular to the c-axis were 0.4388 ± 0.0495 and 0.6829 ± 0.1023 respectively at 199.3°C. This result seems to rule out the interstitial mechanism as the dominant mechanism, and agrees with the assumption that vacancy mechanism (basal and nonbasal) is dominant. (Diss. Abstr. Int., B)

52359 DIFFUSION OF CARBON MONOXIDE IN TANTALUM. Ustinov, Yu. K. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 3, 501-5(Sep 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 3, 643-9(Mar 1971).

The flashing method has been used in a pulsed mass spectrometer (PMS) to show that the diffusion coefficient is $D = 10^{-8} \exp(-10^4/RT)\ \mathrm{cm}^2/\mathrm{sec}$. Fick's equations describe the flash desorption of CO. (auth)

52360 MEASUREMENT OF THE EMISSIVITY OF AUSTENITIC STEELS FOR THE SODIUM COOLED FAST BREEDER REACTOR. Krinninger, H. Warme Stoffuebertrag.; 3: No. 3, 139-45(1970). (In German).

The method used for measuring the emissivity of the steel, the test rig, geometry and surface conditions of the samples, protective gas purity, and test methods are described. The results obtained with two different austenitic steels and different surface roughness are presented for the temperature range 200 to 700°C. (UKAEA Info. Bull.)

52361 PROCHNOST' TUGOPLAVKIKH METALLOV. (Stability of Refractory Metals). Pisarenko, G. S. (ed.). Moscow; Izdatel'stvo Metallurgiya (1970). 367p.

The methodology and the results of experimental studies of the physicomechanical properties of refractory metals and alloys are presented. Studies were conducted in the temperature range of 20 to 3000°C. Descriptions of the test equipment used in the investigations are given. A method was established for the prediction of the change in the stability and plasticity of refractory metals in relation to the temperature and technological and other factors. (tr-auth)

52362 MONOKRISTALLY TUGOPLAVKIKH I REDKIKH METALLOV. Materialy III Vsesoyuznogo Soveshchaniya Poluchenie, Struktura, Fizicheskie Svoistva i Primenenie Monokristallov Tugoplavkikh i Redkikh Metallov, 2-4 Dekabrya 1968 g, Moskva. (Monocrystals of Refractory and Rare Metals. Reports of the Third All-Union Conference on Preparation, Structure, Physical Properties, and Uses of Monocrystals of Refractory and Rare Metals, December 2-4, 1968, Moscow). Savitskii, E. M. (ed.). Moscow; Izdatel'stvo Nauka (1971). 184p. (CONF-681232).

Recent developments in the subject of monocrystals of refractory and rare metals are divided into two areas: (1) development processes and purification, and (2) structure and properties. In the first part may be found discussions of the production of monocrystals of niobium, tungsten, molybdenum, and refractory carbides, accompanied by pertinent accounts of crystal growth, purification by zone melting and the distribution of impurities in the product, and the determination of oxygen in Mo microcrystals. The second and larger of the two sections is chiefly concerned with the substructure and mechanical properties of molybdenum and tungsten, defects and deformation, electroconductivity, and thermionic emission. Miscellaneous papers deal with yield limits of body centered cubic metals, the fine structure of yttrium monocrystals, and the thermoemissive properties of iridium. (K.S.W.)

52363 EFFECTS OF DIFFERENT FISSION PRODUCTS IN THE BETA-GAMMA AUTORADIOGRAPHY. Candela, Ciro; Cesarano, Catello F.; Trezza, Gaetano (CNEN, Rome). Nucl. Technol.; 12: No. 3, 324-8(Nov 1971).

Beta-gamma autoradiography is a widely used technique for studying fission products distribution in nuclear fuels. The contribution of individual fission products which are involved in beta-gamma autoradiography has been studied with and without aluminum absorbers. From experimental results it appears that beta-gamma autoradiography as applied to fuel examination is pure beta autoradiography and furthermore there is a strong sensitivity of the emulsion to high-energy beta, such as 3.4 MeV beta emitted by $^{106}\mathrm{Rh}(^{106}\mathrm{Ru})$. (auth)

52364 DENSITY DETERMINATIONS OF ALKALI METALS BY A GAMMA RADIATION ATTENUATION TECHNIQUE. Dillon, I. G.; LeVert, F. E.; Loretan, P. A.; (and others) (Tuskegee Inst., Ala.). Nucl. Technol.; 12: No. 3, 307-13(Nov 1971).

A gamma attenuation method for obtaining the density of alkali metals has been demonstrated utilizing the gamma radiation from a $^{137}\mathrm{Cs}$ source. Density data have been obtained by this method for Cs and Li up to 1053°K. Data obtained to date for Cs are in agreement with published values; data obtained for Li are scattered and are lower than published values. (auth)

52365 STRUCTURE AND PROPERTIES OF CONTACT ALLOYS OF THE INDIUM-LEAD SYSTEM. Kuznetsov, G. M.; Rogel'berg, L. N.; Soboleva, V. M.; Podkovkina, V. N. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 5, 108-10(1970). (In Russian).

The electric resistance, microstructure, linear expansion coefficient, and phase composition of In-Pb alloys used for electric contacts were studied after annealing at 120°C and also after thermal cycling at −60 to +20°C. Alloys in the ranges 15 to 20 and 30 to 50% Pb were of a two-phase nature in the annealed state. During heating and cooling phase transformations occurred, an important fact to be remembered when considering the design of electric contacts subjected to heating and cooling. The equiatomic alloys had a specific electrical resistance of 0.386 $\Omega.\mathrm{mm}^2/\mathrm{m}$ at room temperature, five times that of pure In. (Metals Abstr.)

52366 SOLID SOLUBILITY OF ZIRCONIUM IN MOLYBDENUM. Zakharov, A. M.; Parshikov, V. G.; Belykh, Yu. A. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 5, 126-8(1970). (In Russian).

The solid solubility of Zr in Mo was studied by microstructural analysis of samples quenched from various temperatures, together with measurements of microhardness. The solubility of Zr in Mo fell from 5 to 2 wt. % on reducing the temperature from 1800 to 1200°C; the maximum solubility (extrapolated to 1900 to 2000°C) never exceeded 10%. These results are in accordance with existing data relating to the Mo-Zr phase diagram. (Metals Abstr.)

52367 MASS-SPECTROMETRIC INVESTIGATION OF SURFACE IONIZATION. IX. DESORPTION OF URANIUM AND THORIUM NEUTRALS FROM RHENIUM. DESORPTION OF THORIUM NEUTRALS FROM TUNGSTEN. Smith, David H. (Oak Ridge National Lab., Tenn.). J. Chem. Phys.; 55: No. 3, 1482-4(1 Aug 1971).

Desorption energies, interaction frequencies, and mean residence times were determined for Th and U neutrals on recrystalline Re and for Th neutrals on polycrystalline W surfaces. The Schottky equation for the ionic desorption energy $E_i = E_a + (I - \phi) + \Delta Q$ was used to study the ionic state on the surface; ΔQ was found to be within experimental uncertainty of zero, indicating that no long-lived surface ionic state exists. (D.L.C.)

52368 SCANDIUM EFFECT ON COPPER AND SOME COPPER ALLOYS PROPERTIES. Zakharov, M. V.; Zakharov, A.

M.; Popov, O. P.; Dashevskaya, N. E. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 4, 117-21(1970). (In Russian).

The solubility of Sc in Cu and Cu alloys was studied by differential thermal analysis, x-ray diffraction, and microhardness methods and its effects on the electrical, mechanical, and welding properties of Cu–Fe–Ti, Cu–Cr, and Cu–Cr–Zr alloys were determined. The maximum solubility of Sc in Cu at the eutectic temperature of 865°C was 0.35 wt %. The introduction of 0.3 to 0.5% Sc into Cu alloys with melting point above 1000°C was undesirable as it sharply reduced the solidus temperature. The addition of 0.1 wt % Sc had little effect on the electrical and mechanical properties but was harmful in relation to welding, as it tended to promote cracking. (Metals Abstr.).

52369 INVESTIGATION OF LOW-ALLOYED INDIUM–GOLD ALLOYS. Kuznetsov, G. M.; Rogel'berg, L. N.; Soboleva, V. M.; Borisova, N. N. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 4, 122-4(1970). (In Russian).

The electric conductivity and linear expansion coefficient of In alloys containing Au 0.1 to 3% were studied and compared with those of approximately equiatomic alloys. Despite the negligible solubility of Au in solid In, particles of the intermetallic compound $AuIn_2$ tended to coalesce vigorously on annealing, and these affected the properties in question, particularly the electric conductivity. The existence of the $AuIn_2$ phase was accordingly an important factor in using these alloys for electric contacts. (Metals Abstr.)

52370 EFFECT OF NITRIDING ON THE MECHANICAL PROPERTIES OF NIOBIUM. Kiparisov, S. S.; Levinskii, Yu. B.; Strogonov, Yu. D. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 4, 125-8(1970). (In Russian).

The effects of nitriding on the ultimate tensile strength (UTS), ductility, and hardness of Nb were studied. Nitriding was particularly advantageous in increasing the surface hardness of this metal. The optimum conditions comprised nitriding at 1100°C for 2 to 3 hr after which the hardness rose to 230 to 240 HV at the surface and 210 to 220 HV at a distance of 100 μm from the surface. Further raising the nitriding temperature, however, was undesirable, as it seriously reduced the ductility, and at very high temperatures the UTS as well. (Metals Abstr.)

52371 HEAT RESISTANCE OF DISPERSION-HARDENED COPPER. Pashkova, O. A.; Makarova, N. I.; Zhuk, N. P.; Opara, B. K. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 4, 136-40(1970). (In Russian).

The heat resistance of Cu dispersion-hardened by means of ZrO_2, Cr_2O_3, and ThO_2 was studied. Both these oxides yielded a substantial improvement in heat resistance owing to the filling of the cation vacancies in the developing Cu_2O with Zr^{4+} and Th^{4+} ions, as well as the presence of the oxides as independent phases. Slight perturbations in the oxidation curve of this material at 600 to 700°C were attributed to the growth of scale accompanied by the formation of cavities or aggregates of oxide particles at the metal/scale interface. (Metals Abstr.)

Structure and Phase Studies

Refer also to abstracts 52607, 52737, and 52965.

52372 (CONF-711001–(Vol.1), pp 96-101) CRYSTAL STRUCTURE OF THE INTERMETALLIC COMPOUNDS $Pr_2Co_{1.7}$ AND $Nd_2Co_{1.7}$. Schweizer, J.; Strnat, K. J.; Tsui, J. B. Y. (Dayton Univ., Ohio). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

A crystal structure is reported for the two previously unknown intermetallic compounds of the approximate compositions $Pr_2Co_{1.7}$ and $Nd_2Co_{1.7}$. The compounds crystallize in a very simple hexagonal cell with parameters a = 4.81 Å, c = 4.09 Å, and a = 4.79 Å, c = 4.07 A, respectively. This cell contains two rare earth atoms in the positions (2/3, 1/3, 1/4) and (1/3, 2/3, 3/4). These are the positions corresponding to a hexagonal packing ABAB. The cobalt atoms are located in x = y = 0 and form columns parallel to the c-axis along which the Co atoms are in contact with each other. These columns fit into cylindrical interstices between the rare earth atoms. The c-parameter of the cell is too small for two cobalt atoms to be present in both the (0, 0, 0) and (0, 0, 1/2) positions. But the shortest distance between rare earth atoms in the basal plane is large enough to permit formation of a continuous row of Co atoms in the z-direction at distances of 2.37 Å, with a stacking period independent of that of the rare earth. The correlation between the Co columns is weak. This gives rise to diffuse planes in reciprocal space perpendicular to the c-axis. (auth)

52373 (CONF-711001–(Vol.1), pp 361-7) SAMARIUM–GOLD AND DYSPROSIUM–GOLD ALLOY SYSTEMS. McMasters, O. D. (Iowa State Univ. of Science and Technology, Ames. Inst. for Atomic Research). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Phase diagrams of the samarium–gold and dysprosium–gold alloy systems based on microscopic, differential thermal, and x-ray diffraction analyses are proposed. Six intermetallic compounds form in both systems. Two and three compounds in the Sm–Au and Dy–Au systems, respectively, melt congruently. SmAu exists in three polymorphic forms and DyAu and $SmAu_2$ are dimorphic. $SmAu_3$ exists only at high temperatures and decomposes eutectoidally. Three eutectic reactions occur in the Sm–Au system and four occur in the Dy–Au system. The solid solubility of both Sm and Dy in Au is known and most of the crystal structures of the compounds have been determined. (auth)

52374 (CONF-711001–(Vol.1), pp 368-78) LATTICE CONSTANTS FOR MIXED INTERMETALLIC PHASES OF THE TYPE $R_2(Co_{1-x}Fe_x)_{17}$. Ray, A. E.; Harmer, R. S. (Dayton Univ., Ohio. Research Inst.). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Single-phase $R_2(Co_{1-x}Fe_x)_{17}$ alloys of the rhombohedral Th_2Zn_{17}-type have been prepared from x = 0 to x = 1 for R = Ce, Pr, Nd, Sm, Y, and MM (Ce-rich mischmetal). Strongly positive deviations from linear behavior of the hexagonal c-axis lattice parameters of the ternary phases were noted. The abnormal c-axis expansion appears to result from the combined effects of increased magnetic ordering temperatures of the R_2Fe_{17} phases conferred by the addition of cobalt and negative exchange interactions of iron atoms occupying sensitive positions in the structures. (auth)

52375 (CONF-711001–(Vol.1), pp 379-85) PHASE TRANSFORMATION IN YTTERBIUM METAL THIN FILMS. Boulesteix, C. (Paris Univ., Orsay (France). Institut d'Optique); Caro, P. E.; Gasgnier, M.; La Blanchetais, Ch. Henry; Schiffmacher, G. (Centre National de la Recherche Scientifique, Bellevue (France). Laboratoire des Terres Rares). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Thin films of ytterbium metal deposited as the well-known fcc phase exhibit a transformation to a hcp phase by annealing in vacuo at 500°K. The hcp phase crystals are large and the thin film has a tightly oriented texture, the plane of the film being parallel to the compact plane (002). Under the beam of the electron microscope large hcp crystals can be observed to grow from fcc crystals, but further heating with the electron beam induces a transformation of the large hcp crystals back to fcc. The two phases are in epitaxial continuity. This last transformation is probably induced by stresses. This apparent phenomenon of polymorphism is discussed. (auth)

52376 (CONF-711001–(Vol.2), pp 617-29) VALENCE BOND FORMATION IN THE RARE EARTH COMPOUNDS HAVING THE $CaCu_5$ STRUCTURE. Carter, Forrest L. (Naval Research Lab., Washington, D. C.). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The rare earth compounds reported to have the $CaCu_5$ structure are examined using the concepts of Pauling's metallic radii, Wigner–Seitz cell volumes, and bidirectional orbitals. The results for the lanthanon indicate both that its effective radius must contract, especially in the series containing the smaller transition metals Fe, Co, and Ni, and that the rare earth position in the basal plane is unstable under the assumption of an anisotropic radius. The specter of the distortion of the $CaCu_5$ structure away from P6/mmm symmetry is partly put to rest by the concept of an anisotropic radius depending upon anisotropic shielding of the bonding electrons by the f electrons. The participation of f orbitals in the basal plane bonds is also considered. (auth)

52377 (CONF-711001–(Vol.2), pp 638-44) FORMATION OF METASTABLE LOW TEMPERATURE ALLOTROPIC SOLID SOLUTIONS IN RARE EARTH–ZIRCONIUM SYSTEMS. Wang, R. (University of Southern California, Los Angeles. Dept. of Materials Science). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The mutual solid solubilities of heavy rare earth metals (Gd, Tb, Dy, Ho, Er, and Lu) with zirconium have been greatly extended by rapid quenching the alloys from the molten state to

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room temperature. All the retained solid solutions are in the low temperature allotropic form (hcp). The solubility limits were determined by x-ray parametric measurements. Compared to the solubilities for alloys obtained in the equilibrium conditions, the solubility limits of the metastable solid solutions increase up to five times from Gd to Tb. Continuous series of solid solutions are obtained in Dy−, Ho−, Er−, and Lu−Zr systems. This is the first instance that continuous solid solutions of rare earths are formed with an element outside its own group. The final observed metastable solid solubilities are correlated to the combined influences of both the size factors and the c/a ratios for the elemental crystal structures of rare earth and zirconium elements. (auth)

52378 ELECTRON MICROSCOPICAL INVESTIGATION OF THE METAL-OXIDE INTERFACE OF ZIRCONIUM ALLOYS. **Tolksdorf, Erich; Lindbo, Joergen (Danish Atomic Energy Commission, Risoe). Prakt. Metallog.; 8: No. 6, 371-4(Jun 1971). (In German and English).**

A preparation technique for replicas of samples for electron microscopic studies of metal−oxide interfaces in Zr alloys involves placing a sample inside a steel tube placed upright on a glass plate, pouring Woods metal around the sample to produce continuity between the mounting medium and the oxide layer, and then preparing a plastic replica of the Woods metal, oxide layer, and metallic phase. This replica can then be subjected to evaporated C and Ge to form films of these on the replica. Electron micrographs obtained from replicas prepared by this technique are reproduced. (B.L.M.)

52379 ISOTHERMAL SECTION OF THE Mo–Zr–Cr CONSTITUTION DIAGRAM AT 1500°C. **Eremenko, V. N.; Prima, S. B.; Tret'yachenko, L. A.; Khoruzhaya, V. G. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 2, 148-50(Feb 1971).**

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 2, 81-4(Feb 1971).

Results of research in which the isothermal section of Mo−Zr−Cr at 1500°C was investigated are described. Discussions of the results are included along with tabulated data and a section diagram. (J.R.D.)

52380 STUDY OF VARIOUS TYPES OF STRUCTURAL TRANSFORMATIONS CHARACTERIZING THE Zr–Nb ALLOY WITH 17 WEIGHT PERCENT NIOBIUM. **Texier, C.; Van Effenterre, P.; Cizeron, G. (CEN de Saclay, Gif-sur-Yvette, France). J. Nucl. Mater.; 40: No. 3, 271-83(Sep 1971). (In French).**

This study was carried out mainly by quenching followed by isothermal annealing or continuous heating. X-ray diffraction, micrography, microhardness and dilatometry during quench were employed. By stepped quenching, it was found that the high-temperature β phase decomposes in different ways—either partial decomposition into α_{Zr}, leading finally to the (α_{Zr} + β_{Nb}) mixture indicated by the phase-diagram, or a diffusion-transformation into ω', or else a diffusionless transformation into ω. A fast quench breaks down the phase into a complex ($\beta + \omega + \beta''$) structure. During isothermal anneals the β'' phase was found to vanish, while either ω' or α_{Zr} was formed according to temperature; meanwhile residual β became enriched in niobium. During continuous heating at rates less than 150°/hr; the quench-product, ω, reverts to β; then, above 600°C, is transiently deposited but disappears again above 700°C to yield the equilibrium high-temperature phase, β containing 17 wt % niobium. (auth)

52381 CONTRIBUTION TO THE STUDY OF THE PLUTONIUM–COPPER DIAGRAM. **Lataillade, F.; Pons, F.; Rapin, M. (CEN de Bruyere-le-Chatel, Montrouge, France). J. Nucl. Mater.; 40: No. 3, 284-8(Sep 1971). (In French).**

The compounds $PuCu_2$ and $PuCu_4$ were formed by solid state diffusion. The growth kinetics and the formation mechanism of these phases were studied using couples constituted of a biphased Pu−Cu alloy and of pure copper. A ternary phase of approximative composition $PuCu_3$ with a variable amount of Ga was formed using couples constituted of pure copper and of PuGa alloys. Crystalline parameters are determined by the Debye−Sherrer method on alloys obtained by direct elaboration or by diffusion. (auth)

52382 INFLUENCE OF PRESSURE ON THE Pu–Ga PHASE DIAGRAM. **Roux, C.; Le Roux, P.; Rapin, M. (CEN de Bruyere-le-Chatel, Montrouge, France). J. Nucl. Mater.; 40: No. 3, 305-10(Sep 1971). (In French).**

The phase diagram (P, T) was determined for Pu−n at. % Ga alloys (with n = 2, 4, 6, 8) from 20 to 700°C in the 0 to 40 kbar pressure range. From this work, a three-dimensional (P, T, c%) diagram was deduced. The main emphasis was put on the limits of the δ phase field. (auth)

52383 ROOM-TEMPERATURE BASAL SLIP IN ZIRCONIUM. **Dickson, J. I.; Craig, G. B. (Univ. of Toronto). J. Nucl. Mater.; 40: No. 3, 346-8(Sep 1971).**

The results of a study of room-temperature basal and prismatic slip in zirconium employing a technique for etching dislocations which glide after the formation of a thin surface film are reported. Although $\{10\bar{1}0\}\ \langle 1\bar{2}10\rangle$ was the predominant slip system, short basal slip traces were observed sufficiently frequently to justify the suggestion that this is an important secondary slip system in α-zirconium. On two single crystals, stressed in three-point bending, basal slip preceded prism slip without the occurrence of twinning. The stresses for dislocation motion and the character of the moving dislocations were calculated assuming slip on the most highly stressed basal slip system and dislocations perpendicular to the slip traces. The dislocation character is reported by the angle between the Burgers vector and the direction which is contained in the slip plane and which is perpendicular to the surface trace of this plane. (auth)

52384 DIAGRAM OF NICKEL–RHENIUM STATE. **Savitskii, E. M.; Tylkina, M. A.; Arskaya, E. P. (Inst. of Metallurgy, Moscow). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 4, 113-16(1970). (In Russian).**

The phase diagram of the Ni−Re system was studied by microstructural analysis, x-ray diffraction, and measurements of electrical resistance and microhardness, and the results were compared with existing (inadequate) data. The diagram is of the peritectic type, no chemical compounds being detected. A peritectic reaction occurred at 1620°C. Solid solutions of Re in Ni extended up to 40 wt % at this temperature, falling to 31 wt % at 800°C. Such Ni−Re alloys are promising as materials for electrical vacuum apparatus. (Metals Abstr.)

Radiation Effects

Refer also to abstracts 51950, 52467, 52897, 52901, 53908, 54072, 54096, 54109, 54110, 54193, and 54286.

52385 (A/CONF.49/P–159) METALLURGICAL PROPERTIES OF ZIRCONIUM-ALLOY PRESSURE TUBES AND THEIR STEEL END-FITTINGS FOR CANDU REACTORS. **Evans, W.; Ross-Ross, P. A.; LeSurf, J. E. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.); Thexton, H. E. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). May 1971. 20p. (CONF-710901–176). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Considering irradiation effects on strength and resistance to creep, corrosion and fracture, cold-worked Zr−2.5 wt % Nb is the best material for pressure tubes in water-cooled CANDU reactors. The life-limiting factor is radiation-enhanced creep, but under design conditions transverse deformation will not exceed 3% in 40 yr. In organic-cooled CANDU reactors the life-limiting criteria are corrosion and hydrogen; nevertheless, lives of at least 15 years are predicted. Pressure tubes can sustain severe defects without failing catastrophically; thus leak-before-fail is predicted. Irradiation increases the NDT temperature of AISI 403. Low-alloy Cr−Mo steel is more resistant to irradiation than is AISI 403. (auth)

52386 (A/CONF.49/P–189) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. **Crispino, E. (AGIP Nucleare, Milan (Italy)); Fizzotti, C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)); Gasparini, R.; (and others) (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). May 1971. 23p. (CONF-710901–156). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Results of Italian research on irradiation of structural materials, mainly concrete and steels used for construction of reactor pressure vessels, are reported and discussed. (D.H.M.)

52387 (A/CONF.49/P–393) NEUTRON EMBRITTLEMENT OF PRESSURE VESSEL STEELS FOR WATER-COOLED REACTORS: ACTIVITIES IN THE FEDERAL REPUBLIC OF GERMANY AND PRINCIPAL RESULTS. **Garzarolli, F. (Allgemeine Elektricitaets-Gesellschaft, AEG-Telefunken, Grosswelzheim (West Germany)); Leitz, C. (Siemens A.G., Erlangen (West Germany));**

Sievers, G. (Kernforschungsanlage, Juelich (West Germany)). Apr 1971. 15p. (CONF-710901-138). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Details are listed on the materials, dimensions, manufacturing methods, and the expected neutron fluences of the reactor pressure vessels now under construction or in operation in the Federal Republic of Germany. The ways in which neutron embrittlement is considered in the design and the mechanical methods of its evaluation are described. The experimental quantities for the degree of neutron embrittlement are the increase of the notch-impact transition temperature and measurements of fracture toughness. From published neutron embrittlement data on the steels used, the scatter band for the transition temperature increase is plotted as a function of the fluence, and is compared with the design values employed so far. In particular, a check is made to see if the design values can be improved by closer specifications of certain material properties. The principal experimental activities on neutron embrittlement of pressure vessel steels in Germany include surveillance and development programs. Steels now being used and promising high-strength steels and their weldments are under investigation. Various compositions, heat treatments, irradiation temperatures, neutron fluences and sample geometries are being studied. Altogether some 3000 notch-impact, tensile and K_{Ic} specimens were irradiated in the VAK, KWO and FRJ 2 reactors. Results obtained to date show that the increase in transition temperature of the presently used steel (ASTM A508 class 2) covers the lower range of the scatter band mentioned above. From two MnNiMoV steels with nickel contents of 0.7 and 1.5% the latter shows a slightly higher embrittlement. At 300°C, a high strength NiCrMo steel displayed a low embrittlement tendency at fluences of 10^{19} n/cm^2 (E > 1 MeV). At an irradiation temperature of 400°C, there is no appreciable embrittlement, even at 10^{20} n/cm^2. The influences of the other parameters mentioned are discussed. (auth)

52388 (A/CONF.49/P–428) CORROSION BEHAVIOUR OF ZIRCONIUM ALLOYS IN BOILING WATER UNDER IRRADIATION. Amaev, A. D.; Anisimova, J. A.; Niculina, A. V.; Saenko, G. P.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 21p. (CONF-710901-378). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The results of an investigation of zirconium alloys to be used in fuel element cladding of the water-water and boiling reactors and in thick-wall tubes of the boiling water channel-type reactor are discussed. The alloys with varying amounts of Nb, Fe, Ni, Cu, and Sn were investigated. Data on the effects of alloy impurities on the alloy corrosion in water were obtained; the influence of preheat treatment on the alloy corrosion and mechanical properties and structure was determined. Experimental data on zirconium alloy behavior in boiling water containing up to 20 wt % of vapor in the loops of the MP reactor are presented. Corrosion, tendency to hydrogen absorption, change of mechanical properties, and material structure were investigated. Under irradiation some alloys (alloy specimens and test fuel element claddings) showed a sharp rise in corrosion and hydrogen absorption. (auth)

52389 (A/CONF.49/P–453) PROPERTIES AND BEHAVIOUR OF IRRADIATED STEELS FOR FAST REACTOR FUEL ELEMENT CLADDING. Agapova, N. P.; Voronin, I. M.; Votinov, S. N.; Prokhorov, V. I.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, [Moscow]). Jun 1971. 27p. (CONF-710901-357). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Results of post-irradiation studies of various classes of stainless steels and nickel-base alloys within a wide temperature are presented. The structure and mechanical properties were investigated within the temperature range of 350 to 700°C (taking account of the fast reactor fuel element can operating conditions). In most materials under consideration subjected to the post-irradiation high-temperature test, a decrease in plasticity (high-temperature embrittlement) was observed. The high-temperature embrittlement is connected with radiation-induced changes in the mechanical and elastic properties of grains and grain boundaries. The effects of the chemical composition of Ni, B, Mo, Nb, and other elements and their alloys on high-temperature embrittlement were studied. The effect of the grain sizes on this phenomenon was also studied, in particular, the role of the boundaries in the high-temperature embrittlement of nickel. The reactor irradiation data are compared with the test results of steels irradiated by helium ions in a cyclotron where it was demonstrated that helium can stimulate radiation-induced high-temperature embrittlement. The effect of the integral flux on the mechanical properties following irradiation in the SM-2 and BR-5 reactors with different neutron spectra was noted. The work performed allowed an evaluation of materials for fast reactor fuel element cans to be made. (auth)

52390 (A/CONF.49/P–499) IRRADIATION EFFECTS IN FAST REACTOR CLADDING AND STRUCTURAL MATERIALS. Harries, D. R.; Bullough, R. (Atomic Energy Research Establishment, Harwell (England)); Cawthorne, C.; Mosedale, D.; (and others) (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). Jun 1971. 14p. (CONF-710901-294). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The results of post-irradiation high-temperature tensile and creep-rupture (uniaxial, biaxial, and internal pressure tube-burst) tests on sodium-cooled fast reactor cladding and structural materials such as Type 316 and FV548 austenitic steels and Nimonic PE16 alloy are described. These illustrate the effects of irradiation, metallurgical, and testing variables on the changes in strength and ductility characteristics induced by irradiation in thermal reactors or to doses up to 1×10^{23} n cm^{-2} (total) in the Dounreay Fast Reactor (DFR). Data obtained from tension loaded spring creep tests at ~270°C in DFR are presented and show that in-pile strain rates for both solution treated and cold worked Type 316 steel are enhanced relative to those in the absence of irradiation. Irradiation-induced void formation and swelling is exemplified by the results of density measurements and transmission electron microscopy on unstressed Types 316 austenitic steel irradiated at temperatures in the range 230 to 680°C and to doses $\lesssim 3.3 \times 10^{22}$ n cm^{-2} (total) in DFR. In addition, the relationships between diameter and density changes and void sizes and concentrations in the cladding (Type 316 and FV548 austenitic steels and Nimonic PE16 alloy) of experimental fuel pins irradiated in DFR are detailed as a function of neutron dose and temperature. The technique of quantitatively simulating the void swelling in fast neutron irradiated materials by charged particle bombardment from accelerators is summarized. Results are presented on the variation of the void swelling in nickel, austenitic steels, and Nimonic PE16 alloy with inert gas content, displacement dose, temperature, and cold work level. Finally, the principal features of a theoretical model developed for the study of the temperature dependence and kinetics of void growth are described and theoretical predictions are presented to clarify the effects of defect recombination, dislocation density, void density, and dose rate on void swelling. (auth)

52391 (A/CONF.49/P–502) IRRADIATION EFFECTS IN ZIRCONIUM ALLOY PRESSURE TUBES. Nichols, R. W.; Pickles, B. W. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group); Asher, R. C. (Atomic Energy Research Establishment, Harwell (England)); Hesketh, R.; (and others) (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jun 1971. 14p. (CONF-710901-222). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Neutron irradiation of zirconium alloy pressure tubes can produce changes in their corrosion resistance, fracture toughness, creep strength, rupture ductility, and dimensions. New results are presented on each of these aspects from experiments in material test reactors and from surveillance measurements made on the Steam Generating Heavy Water Reactor (SGHWR) In-reactor corrosion was studied in moist carbon dioxide atmospheres corresponding to the outer surface conditions of an SGHWR pressure tube, similar enhancement by radiation being found to that observed in water and steam environments. Corrosion measurements in water and steam were obtained from surveillance specimens which had been enclosed in perforated SGHWR fuel cans; while detailed differences in corrosion rate and hydrogen pick-up were observed for different material conditions, the results demonstrated that these aspects will not cause problems in current designs. With regard to fracture toughness, new results extending to doses of 1.10^{26} n/m^2 (fast) show that irradiation damage is virtually saturated at 1.10^{24} n/m^2. Tests on hydrided tubes, on surveillance samples and on lengths of actual pressure tube removed from SGHWR confirm the high resistance of such tubes to fast fracture even after exposure to the worst conditions envisaged in a reactor lifetime. Measurements of the bore dimensions of operational SGHWR tubes showed good agreement with predictions made from an in-pile creep strain equation derived from review of extensive experimental irradiations; factors affecting the scatter of behavior around

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this best estimate are discussed. In high-strain in-pile creep tests on Zircaloy-2 specimens no fractures have yet been achieved even though a strain of 8% was exceeded. These results confirm that in-pile creep ductility is considerably higher than would be predicted from out-of-pile tests. (auth)

52392 (HEDL-SA-202) COMPUTER SIMULATION OF THE SHORT-TERM ANNEALING OF DISPLACEMENT CASCADES. Doran, D. G.; Burnett, R. A. (Hanford Engineering Development Lab., Richland, Wash.). Apr 1971. Contracts AT(45-1)-1830; AT(45-1)-2170. 35p. (CONF-710621-2; CONF-710622-2). Dep. NTIS.

From Conference on interatomic potentials and simulation of lattice defects; Seattle, Wash. (14 Jun 1971).

An important source of damage to a solid exposed to high energy neutrons (or ions) is the displacement of atoms from normal lattice sites. In a fast reactor, energies of tens of keV may be transferred to an atom and thus initiate a displacement cascade consisting of a localized high density of interstitials and vacancies. These defects will subsequently interact with one another to form clusters and to reduce their density by mutual annihilation. This short-term annealing has been simulated with a small computer using an atomic model of γ-iron based on the work of Johnson. The input cascades are due to Beeler. Results were obtained with both large (104 sites) and small (32 sites) annihilation regions. The former results in about one-half the residual defects of the latter, and a smaller fraction of clustered defects. Cluster size distributions and several examples of spatial distributions are given. It is shown that the principal effect of randomizing the spatial distribution of defects in a typical cascade geometry is to diminish vacancy clustering and enhance interstitial clustering. (auth)

52393 (JPRS-53800) SOLID STATE RADIATION PHYSICS AND REACTOR MATERIALS RESEARCH. Translation of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970. 317p. NTIS.

This collection contains 30 articles on investigations of radiation damage and stability of reactor materials. The research was carried out in the Scientific Research Institute of Atomic Reactors by studying materials in hot cells and the SM-2 research reactor. Discussion of the resultant materials is prefaced by a description of the procedures used for irradiation and postreactor investigations. Separate abstracts were prepared for all the articles. (auth)

For abstracts of individual papers see: 51765, 52394–52408, 52473–52477, 52897–52903, 53919, and 54289.

52394 (JPRS-53800, pp 79-86) BEHAVIOR OF RADIATION DEFECTS ON COHERENT TWIN BOUNDARIES IN NICKEL. Votinov, S. N.; Grinchuk, P. P.; Ostrovskii, Z. E. Translated from pp 66-72 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A study was made of the influence of a fast neutron flux (5×10^{21} cm^{-2}) on the structure of twin boundaries of 99.96%-pure Ni at 70°C in the SM-2 reactor. The specimens were examined by transmission electron microscopy after annealing at 425 to 500°C; dislocation loops were found to grow at coherent twin boundaries but not at incoherent ones. These loops are probably due to the interaction of focusing collisions with the coherent boundary. The loops are the sessile loops of Franck with a Burgers vector of $\frac{1}{3}$ a [111]. (D.L.C.)

52395 (JPRS-53800, pp 87-97) INFLUENCE OF IRRADIATION ON THE STRUCTURE OF SEVERAL PRECIPITATION-HARDENED STEELS. Votinov, S. N.; Grinchuk, P. P.; Ostrovskii, Z. E.; Prokhorov, V. I. Translated from pp 73-82 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

Electron microscopic investigations were made after fast-neutron irradiation either at 680 to 700°C or at 70°C, of the three precipitation-hardened stainless steels OKh16N15M3B, OKh16N15M3BR, and OOKh16N15. The irradiation does not lead to appreciable carbide precipitation of $Cr_{23}C_6$, whereas considerable precipitation of $MoFe_2$ and borides occurs. A schematic is proposed for the effect of irradiation on the aging behavior of the steels. (D.L.C.)

52396 (JPRS-53800, pp 98-112) ROLE OF IRRADIATION IN HIGH-TEMPERATURE BRITTLENESS OF STEELS. Votinov, S. N.; Prokhorov, V. I.; Balashov, V. D.; Shamardin, V. K. Translated from pp 82-94 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A study was made of the effects of fast neutrons (2×10^{20} to 10^{22} cm^{-2}) at high temperatures on the 20 to 800°C tensile elongation of Fe, various stainless steels, and nickel alloys. It was found out that an increase in the Ni content led to reduced plasticity. The greatest stability of plastic properties after irradiation is possessed by the 16–15 Mo–Nb–B steel containing ~0.005% B. Effects of annealing were also studied. A schematic is presented for the radiation embrittlement of alloys in the Fe–Cr–Ni system. Possible causes of the embrittlement (aging, impurities, defects, etc.) are discussed. (D.L.C.)

52397 (JPRS-53800, pp 113-21) CHANGE IN THE STRENGTH AND PLASTIC CHARACTERISTICS OF IRON AND ITS ALLOYS WITH CHROMIUM AS A RESULT OF IRRADIATION. Balashov, V. D.; Votinov, S. N.; Prokhorov, V. I.; Shamardin, V. K. Translated from pp 94-101 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

The effects of low-temperature neutron irradiation (7×10^{21} cm^{-2}) on the 20 to 800°C mechanical properties of Armco iron, Fe–20 wt % Cr, and chrome steel of Kh13 type were studied. The structure of failed Fe was also studied. The drop in ductility after irradiation of chrome steels and iron is not catastrophic as in Cr–Ni steels. (D.L.C.)

52398 (JPRS-53800, pp 122-43) INFLUENCE OF IRRADIATION ON THE MECHANICAL PROPERTIES OF ALLOYS IN THE SYSTEM Fe–Cr–Ni. Balashov, V. D.; Votinov, S. N.; Prokhorov, V. I. Translated from pp 101-20 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A study was made of high-temperature radiation embrittlement of a successive series (with increasing Ni from 15 wt % to pure nickel) of nickel alloys with chromium based on iron and nickel: Kh20N15, Kh30N40, Kh20N60, Kh20N80 and pure nickel. The results of these studies of the effects of high-temperature annealing (1050°) indicated that the reduced high-temperature plasticity of irradiated specimens is partially restored. This allows to consider the annealed radiation defects to be a significant factor in the effect of high-temperature embrittlement. (tr-auth)

52399 (JPRS-53800, pp 144-63) CREEP CHARACTERISTICS IN STAINLESS STEELS AFTER IRRADIATION. Votinov, S. N.; Shamardin, V. K.; Prokhorov, V. I. Translated from pp 121-38 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

Measurements were made of long-term strength and creep at 630 to 730°C, after fast-neutron irradiations to 10^{22} cm^{-2} at either 50 to 70°C or 700°C. The materials studied were Kh18N10T, Kh15N28V2M4B, KhN35V3T, Kh16N15M3B, and Kh16N15M3BR. A metallographic examination was also made of the microstructure of the Kh16N15M3BR after testing for long-term strength. The results are discussed and possible causes considered. (D.L.C.) (D.L.C.)

52400 (JPRS-53800, pp 164-75) INFLUENCE OF ORIGINAL STATE OF MOLYBDENUM ON RADIATION HARDENING AT HIGH TEMPERATURES. Aleksandrov, S. I.; Bazyukin, V. G.; Votinov, S. N.; Zakharov, A. R.; Kazakhov, V. A.; Razov, I. A. Translated from pp 139-49 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

Samples of metal-ceramic, fused, and monocrystalline Mo were irradiated at 750 and 1200°C by fast neutron doses of 1.5×10^{20} cm^{-2}. Tensile properties were measured at 20 to 800°C, and the changes in microstructure, microhardness, and lattice parameter were determined. (D.L.C.)

52401 (JPRS-53800, pp 176-9) IMPACT VISCOSITY OF IRRADIATED WELD JOINTS OF AUSTENITIC CHROMIUM–NICKEL STEELS. Reviznikov, L. I.; Zinkovskii, V. I.; Krylov, E. A. Translated from pp 149-51 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A study was made of the effects of a fast-neutron irradiation (7×10^{20} cm^{-2}) at 350°C on the impact viscosity of weld joints of the stainless steels Kh18N8T and Kh16N15M3B. The welds were made by the argon arc method without any wire. The irradiation was found to produce a decrease in the impact viscosity. (D.L.C.)

52402 (JPRS-53800, pp 215-22) INFLUENCE OF IRRADIATION ON THE MECHANICAL PROPERTIES OF SINGLE CRYSTALS OF ALPHA–URANIUM OF VARIOUS ORIENTATIONS. Konobeevskii, S. T.; Butra, F. P.; Golovchenko, Yu. M.; Bychkov, B. A. Translated from pp 178-85 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A study was made of whether α–U monocrystals retain significant plasticity in all orientations after irradiation. Irradiations at 5.5×10^{19} and 2×10^{20} cm^{-2} were carried out at <100°C, and the dimensional changes and tensile deformation (stress-strain) were measured. Three groups of monocrystals with different deformation character were identified. Critical cleavage stresses for the plane (010) were determined. (D.L.C.)

52403 (JPRS–53800, pp 223-30) MECHANICAL PROPERTIES OF URANIUM IRRADIATED UP TO 0.45 AT. PERCENT DEPLETION. Golovchenko, Yu. M.; Vorob'ev, M. A.; Bychkov, B. A.; Davidenko, A. S.; Portnov, V. F. Translated from pp 185-91 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A study was made of the effects of irradiations up to 0.45 at. % depletion at temperatures up to 500°C on tensile, compression, bending, and fatigue properties of uranium cylinders. The results show that the strength and plastic properties of irradiated U depend on the type of stressed state and the "strictness" of the tests. The role of intergranular and intragranular defects is discussed. (D.L.C.)

52404 (JPRS–53800, pp 231-6) RADIOGRAPHIC STUDY OF ORIENTATION OF IRRADIATED ALPHA–URANIUM. Deripasko, V. T.; Golovchenko, Yu. M.; Bychkov, B. A.; Tuchnin, L. M. Translated from pp 191-6 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A study was made of radioinduced changes in orientation in polycrystalline samples of α-uranium with differing orientations of deformation and recrystallization. Inverse pole figures and x-ray growth indices were measured using x-ray diffraction after irradiations up to 0.45 at. % depletion. Irradiation was found to lead to a redistribution of densities, with the greatest change occurring at an irradiation temperature of 350°C. (D.L.C.)

52405 (JPRS–53800, pp 237-44) GAS SWELLING OF URANIUM UNDER ANNEALING CONDITIONS. Zavgorodinii, A. Ya.; Gol'tsev, V. P. Translated from pp 197-203 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A study was made of the temperature dependence and kinetics of gas swelling in isothermal annealing of U after irradiation at 300°C to 0.2 and 0.45% depletion. Swelling begins at an annealing temperature of ~425°C. The effects of thermal cycling, beta phase, and gamma phase were studied. (D.L.C.)

52406 (JPRS–53800, pp 245-51) FORMATION OF STRUCTURE OF FUEL ELEMENT CORE OF METALLIC URANIUM IN PROCESS OF IRRADIATION. Kazachkovskii, O. D.; Lebedev, I. G.; Sych, A. P.; Matveev, N. P. Translated from pp 203-8 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A study was made of the fate of various forms of porosity (axial opening, grooves, free mass over core, and microporosity) in stainless steel-clad enriched U fuel elements after irradiation up to 2.1% depletion. Macro- and microstructures were examined. During irradiation, the filling of the free mass was greatest for samples with surface grooves and least for samples with a free mass over the core. The probable swelling mechanism of fuel elements is discussed. (D.L.C.)

52407 (JPRS–53800, pp 258-67) RADIATION DAMAGE TO BERYLLIUM UNDER LOW-TEMPERATURE NEUTRON IRRADIATION. Gol'tsev, V. P.; Chechetkina, Z. I.; Sernyaev, G. A. Translated from pp 213-20 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

The effects of neutron irradiations up to 3×10^{22} cm^{-2} (E > 0.8 MeV) on the density and mechanical properties of hot-pressed and hot-extruded Be were studied. Low-temperature irradiation by 5×10^{21} cm^{-2} does not affect the density or mechanical properties. Increasing the flux to 4×10^{22} cm^{-2} leads to a 1.5% decrease in the density due to the appearance of microcracks and cavities. He atoms are formed which immobilize the vacancies, leading to a growth in microhardness and yield point and to a decrease in plasticity. The appearance of microcracks in reflector blocks is due to thermal stresses and a weakening of grain boundaries, leading to strength loss and embrittlement. (D.L.C.)

52408 (JPRS–53800, pp 268-79) KINETICS OF GAS SWELLING IN IRRADIATED BERYLLIUM. Zavgorodnii, A. Ya.; Gol'tsev, V. P.; Chechetkina, Z. I.; Sernyaev, G. A. Translated from pp 221-31 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A study was made of the temperature dependence and kinetics of gas swelling in hot-pressed Be after 70°C irradiations with up to 2×10^{22} cm^{-2} (E ≥ 0.8 MeV). Dilatometry and metallography were used. Mechanisms of swelling in irradiated Be are discussed. (D.L.C.)

52409 (KFK–1398) FR-2 IRRADIATION CAPSULE FOR INVESTIGATION OF FUEL SWELLING. Haefner, H.; Philipp, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Apr 1971. 35p. (In German). Dep. NTIS (U. S. Sales Only).

The design of fuel pins for advanced nuclear reactors calls for a more accurate knowledge of the swelling and creep behavior, respectively, of nuclear fuel. At the Karlsruhe Nuclear Research Center irradiation capsules were developed in which swelling and creep of nuclear fuels can be measured directly under pneumatic load. A fuel creep capsule which allows continuous in-pile measurement of the longitudinal variation of specimens under axial pneumatic compressive load by means of irradiation-resistant inductive displacement pickups (differential transformer) is described. Information is presented on the fuel swelling capsules in which the parameters power density, sample loading, temperature, and temperature gradient can be set for each individual case and the amount of swelling measured integrally after a desired burnup. Information is also included relating to safety for irradiations at the Karlsruhe FR2 reactor. (auth)

52410 (RD/B/N–1879) USE OF THE HIGH VOLTAGE ELECTRON MICROSCOPE TO SIMULATE FAST NEUTRON INDUCED VOID SWELLING IN METALS. Norris, D. I. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1971. 22p. Dep. NTIS (U. S. Sales Only).

Electron irradiation with the beam of a high-voltage electron microscope can be used to produce void growth in metals, simulating the effect of high-dose neutron irradiation. The advantages of the technique are the high dose rate, the relative simplicity of electron irradiation, and the ability to make observations during irradiation. Problems of determining the vacancy creation rate are discussed. Secondary displacements are not important for 1-MeV electron irradiation of nickel or iron. In nickel, voids are nucleated if gas atoms are present, but preexisting vacancy clusters are not necessary. The void concentration is reduced near incoherent boundaries, the effective denuded layer thickness in nickel being 0.06 μm at 330°C and 0.13 μm at 390°C. Similar denuded layers occur near surfaces, constituting a serious problem of working with thin-foil specimens. Studies of void growth behavior are illustrated by results for stainless steel and for nickel. The roles of the moving dislocations and the surfaces are discussed. Comparisons of swelling versus dose curves with neutron irradiation work suggest that collision cascades are not an important factor. Thermal annealing of voids is not important in nickel at 540°C or below, but radiation-enhanced diffusion effects can occur. (auth)

52411 (TRG-Report–2113) INVESTIGATION OF THE EFFECTS OF NEUTRON IRRADIATION ON THE COARSENING KINETICS OF GAMMA PRIME PARTICLES ON A NICKEL BASED ALLOY. Bilsby, C. F.; Standring, J. (United Kingdom Atomic Energy Authority, Culcheth (England). Reactor Group). 1971. 15p. Dep. NTIS (U. S. Sales Only).

The coarsening rate of the γ' dispersion in Nimonic PE 16 was established for the temperature 600, 650, and 700°C. The increase in mean particle diameter with time at a given temperature is shown to follow the law $d^3 - d_0^3 = kt$ where d_0 is the mean particle diameter at the commencement of aging. k is characterized by an activation energy of 64.5 kcal/mole. The mean particle diameter in specimens irradiated in a neutron flux of about 10^{13} n cm^{-2} sec^{-1} (fission) for times up to 5000 hr in the temperature range 545 to 650°C can be accurately predicted from the thermal data, indicating that there is no enhancement of coarsening rate due to irradiation above 545°C. Specimens irradiated at 400°C under similar flux conditions showed damage in the form of dislocation loops. Associated with these loops were γ' particles of larger than average diameter. A theoretical treatment is developed to obtain an appreciation of the probable effect of flux level on irradiation-enhanced coarsening. (auth) (UK)

52412 INFLUENCE OF NEUTRON RADIATION ON THE YIELD STRESS AND ON SOME ACTIVATION PARAMETERS O POLYCRYSTALLINE VANADIUM. Bocek, M.; Boehm, H.; Schneider, W. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 40: No. 3, 249-70(Sep 1971).

On neutron irradiated polycrystalline vanadium a thermal activation analysis was performed using the stress relaxation method. Irradiation influences both the thermal and the athermal stress component. The radiation hardening at low and intermediate doses can be described according to the dispersed barrier model by a $(\phi t)^{1/2}$-dependence. For high doses saturation phenomena are observed. The rate determining process is not influenced qualitatively by irradiation at doses up to 1×10^{18} n/cm^2. The strength of the rate determining obstacles is reduced at low doses, perhaps as a result of the formation of oxygen-radiation defect complexes. Whereas interstitial oxygen atoms, elementary radiation defects,

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and complexes composed from both suffer a contribution to the thermal stress component, visible defect clusters in this case probably affect only the athermal stress component. As one can imagine, these findings are dependent on the content of relevant interstitial impurities. In this case the dominating role is played by the oxygen atoms. (auth)

52413 EFFECTS OF PREINJECTED HYDROGEN ON THE ELECTRON DISPLACEMENT DAMAGE IN 1100 ALUMINUM. Wolfenden, A. (Oak Ridge National Lab., Tenn.). J. Nucl. Mater.; 40: No. 3, 351-2(Sep 1971).

An investigation of electron irradiation damage in 1100 aluminum (99 wt % purity) is reported. Specimens were examined in two conditions: some were annealed; others were annealed, preinjected with protons and then re-annealed. All anneals were for 30 min at 350°C. Subsequent electron irradiation in the microscope produced visible dislocation loops in only the latter group of specimens. It was concluded that gaseous impurities present at the ppM level can have profound effects on the formation and distribution of electron irradiation-produced dislocation loops in 1100 aluminum. (auth)

52414 EFFECT OF THE NEUTRON ENERGY SPECTRUM ON NEUTRON DISPLACEMENT DAMAGE IN NIOBIUM. Blow, S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., D (London); 4: No. 8, 1107-13(Aug 1971).

An analysis of displacement damage produced in niobium, which has potential use as the first wall material of a fusion reactor, is presented. Lindhard's formalism was used together with cross sections taken from the UK nuclear data file on niobium. Data sets describing damage energy created at various neutron incident energies were generated. It was calculated that the ratio of damage density (i.e. mean damage energy × cross section) at 14 MeV to that at 1 MeV is 3.5 to 1.00. The damage energy data sets were integrated over two different neutron spectra in order to compare the total effects. The spectra were taken from: (a) the first wall of a model fusion reactor, with a total flux of 2.8×10^{15} neutrons/cm^2 s; (b) the core centre of the Dounreay Fast Reactor (DFR), total flux 2.5×10^{15} neutrons/cm^2 s. Analysis showed that the number of atomic displacements per atom per year is 165 displacements for spectrum (a) and 78 displacements for spectrum (b). (auth)

Ceramics and Cermets

Refer also to abstract 52291.

Corrosion and Erosion

Refer also to abstracts 51717, 52299, and 54032.

52415 REACTIONS OF BORIDES OF THE TRANSITION METALS WITH THEIR OXIDES. Marek, E. V.; Kuz'ma, Yu. B.; Kosolapova, T. Ya. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 2, 138-41(Feb 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 2, 70-3(Feb 1971).

Results of a study are presented on the reactions of the diborides of Zr, Hf, Nb, Ta, and Cr with the oxides of these metals at 1000 to 2000°C. (J.R.D.)

52416 HETEROGENEOUS RATE COUPLING FOR GRAPHITE OXIDATION. Baron, J. R.; Bernstein, H. (ManLabs Inc., Cambridge, Mass.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 8, 1588-95(Aug 1971).

Surface oxidation of a refractory material upon exposure to a high-temperature flow field was assessed on the basis of a surface coupled model. The appearance of limiting phenomenological behavior was not presumed. The formulation allowed for both gaseous and solid oxide formations as a result of Arrhenius relations for oxidation kinetics at the gas–solid interface. Numerical results are presented for the case of a laminar boundary layer adjacent to a graphite stagnation point assuming gas phase equilibrium and multicomponent variable transport properties. Multiple mass transfer plateaus were found to be present, each plateau corresponding to a diffusion limit behavior over a surface temperature interval in which a specific gaseous oxide proves to be dominant. Reaction constant magnitudes effectively dictate the transition behavior between plateaus, the departure from the low-temperature reaction controlled region, and the widths of the surface temperature intervals over which individual plateaus are distinct. For graphite recession, the sensitivity of such effects is appreciable relative to uncertainties in rate data. (auth)

52417 REACTION OF LANTHANUM AND CERIUM HEXABORIDES WITH REFRACTORY METALS. Bondarenko, V. P.; Morozov, V. V.; Chernyak, L. V. (Kiev Engineering Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 1, 57-61 (Jan 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 1, 73-8(Jan 1971).

Results of studies of reactions of LaB_6 and CeB_6 with tantalum, tungsten, rhenium, and hafnium at 1700°C are presented. (J.R.D.)

Preparation and Fabrication

Refer also to abstracts 51675, 51720, 52292, 52303, 52362, 54087, 54102, and 54303.

52418 (A/CONF.49/P–26) DEVELOPMENT OF VIBROCOMPACTED FUEL ELEMENTS WITH UO_2 FUEL PREPARED BY THE SOL-GEL PROCESS AND BY ELECTRODEPOSITION. Hamburg, F. W.; van der Kleij, N.; Majoor, E. B. M.; (and others) (Reactor Centrum Nederland, Petten). May 1971. 13p. (CONF-710901–73). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The application of UO_2 spheres, prepared by sol-gel techniques, as feed material for vibrocompacted fuel rods is being investigated. The sol-gel process to produce spheres in the proper size ranges for vibrocompaction is based on a fast precipitation of a UO_3 hydrate from an anion-deficient uranyl nitrate solution by internal gelation at about 90°C. After washing the product is converted into UO_2 by a fast, two step heat-treatment. The influence of particle size and distribution on the densification of the UO_2 particle bed was studied. Densities of about 90% T.D. can be obtained. Irradiation experiments on so-called vibrasol fuel rods were performed are still in progress. In short term irradiation, the central fuel temperature exceeded the melting point of UO_2. Long term irradiations in a pressurized water loop in the High Flux Reactor at Petten have been performed up to a burn-up of 10 MWd/kg. The results of the post-irradiation investigations will be reported. The irradiation of two full size vibrasol fuel elements is in progress in the Halden Boiling Water Reactor in Norway. Two vibrasol elements for the Boiling Water Reactor at Dodewaard are being fabricated. They will be operated in the reactor for a period of two years. In addition, irradiation experiments were performed on vibrocompacted fuel rods, containing high density UO_2 particles obtained by electrodeposition in a salt bath. The maximum burn-up is 16 MWd/kg. Also low burn-up irradiations were carried out with central temperatures exceeding the melting point of UO_2 without influencing the fuel rod integrity. The results will be presented in comparison with those obtained on vibrocompacted fused oxide. (auth)

52419 (A/CONF.49/P–119) PREPARATION OF URANIUM–PLUTONIUM–CARBIDE FUEL PARTICLES. Schumacher, H.; Bischoff, K.; Notz, K. J.; Ogard, A. E. (Swiss Federal Institute for Reactor Research, Wuerenlingen). May 1971. 16p. (CONF-710901–161). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The preparation of uranium-plutonium carbides using sol-gel processes is being studied at EIR. Particle-type carbide fuels, as produced by the carbothermic reduction of sol-gel oxides, promise to be advantageous with respect to both fabrication and irradiation behavior. A review is given of the chemical processes for preparation of urania and plutonia sols, addition of carbon to the sols or sol mixtures, gelation of carbon containing sols, and sphere forming. The carbothermic reduction of the gelled oxides is a most critical step in the production of dense, stoichiometric monocarbides with a reasonably low oxygen content. The problems of reaction sintering are discussed and results of reductions done in argon atmosphere or under vacuum are presented. (auth)

52420 (A/CONF.49/P–146) NEWER TRENDS IN NUCLEAR MATERIALS RESEARCH IN THE UNITED ARAB REPUBLIC. Farah, M. Y.; Hallaba, E.; Zaki, M. R.; (and others) (Atomic Energy Establishment, Cairo (Egypt)). May 1971. 18p. (CONF-710901–83). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Newer trends developed after Geneva III and within the topics of interest to the acutal Conference are reviewed, including problems related to procuring and refining yellow cakes; the impact of APU preparation history on uranium oxide characterization; studies on uranyl hydrazine system; photolysis and the uranyl/ethanol system; dry preparation and sintering of UO_2; and research on heavy water analyses and separation. (D.H.M.)

52421 (A/CONF.49/P-181) ITALIAN ACTIVITIES IN THE FUEL MANUFACTURING FIELD. Amato, I. (FIAT, Turin (Italy). Sezione Energia Nucleare); Facchini, A.; Gerontopoulos, P.; Neri D.; (and others) (Agip Nucleare, Milan (Italy)). May 1971. 23p. (CONF-710901-187). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Progress on Italian activities concerned with fabrication of nuclear fuels is reported. In the core materials field one original process has been developed for production of fuel in the form of microspheres which can be used in HTR reactors after coating and compaction and in other thermal and fast reactors after vibrocompaction in the canning tubes. The process leads to production costs at least 15% lower than any other. Several pilot plants of 15 kg/day capacity have been built and production licenses have been granted to many fuel organizations. As far as fuel fabrication procedures are concerned, the following activities are reported: work performed by CNEN for the designing, setting up and commissioning of a 20 tons/year capacity plant for the fabrication of CIRENE reactor, natural UO_2–Zircaloy-2-clad fuel elements; the development and manufacturing by FIAT of an advanced fuel element prototype with Zircaloy cladding for PWR nuclear power plants core physics and core engineering calculations, and development of manufacturing processes, fixtures, and tooling suitable for the fabrication of this fuel element on an industrial scale have been carried out. A cost analysis for a 200 ton/year plant planned for construction on the basis of processes and technologies already known is presented. The CNEN development of a procedure for the pilot fabrication of 80 subassemblies of UO_2–PuO_2 reference fuel for the fast prototype reactor PEC is described. (auth)

52422 (A/CONF.49/P-197) PRESENT STATUS OF FUEL ELEMENT TECHNOLOGY AT THE INSTITUTO DE ENERGIA ATOMICA, SAO PAULO, BRASIL. de Souza Santos, T. D.; de Freitas, C. T.; Haydt, H. M.; Gentile, E. F.; (and others) (Instituto de Energia Atomica, Sao Paulo (Brazil)). Jun 1971. 17p. (CONF-710901-469). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Studies were carried out on the development of improved Al-clad fuel plates, designed for high flux reactors. These plates contain dense cores of Al-based cermets. It was believed that by increasing the core density, a lesser amount of reactivity would result, even with dispersion of Al with UO_2. An increase of thermal conductivity was sought in order to improve the fuel element performance. Reduction of the initial porosity of the green compacts was studied, with the aim of attaining higher plastic properties and decreasing reactivity. A special device was designed and built for thermal cycling testing. Data are presented on the intrinsic reactivity of dispersions with metallic Al and U compounds as a function of the cermet texture. The plastic behavior of the assemblies was studied with conventional picture frame sets, and also with cast clad ingots of special design. The main variables related to the hot rolling were also determined. The cast cladding technique adopted was described, together with the results obtained for the dimensional control of the plates produced. Metallographic examinations and bonding tests, done by bending a cut plate over a mandrel, show the quality of the bonding achieved. Tests run on final cold rolled, fully clad plates indicate that the developed fuel elements hold promise for utilization in advanced high flux reactors. (22 references) (auth)

52423 (A/CONF.49/P-274) FABRICATION PROCESS AND PROSPECTIVE COSTS FOR FAST BREEDER PLUTONIUM FUEL. Vanden Bemden, E.; de Waegh, F.; Haubert, P. (Societe Belge pour l'Industrie Nucleaire, Brussels). Jun 1971. 20p. (CONF-710901-470). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

On the basis of the technological developments carried out by Belgonucleaire over more than ten years in the field of plutonium fuel fabrication, it is now possible to perform a technico-economic assessment of the two fabrication processes which could prevail for fast reactor fuel, namely the pellet and the vibrocompaction methods. One has deliberately considered only the future industrial context characterized by large plutonium fuel fabrication plants. After a detailed technical comparison of the two processes, the probable fabrication costs of FBR plutonium fuel are evaluated in both cases. The sensitivity of these costs to the many parameters characteristic of fuel specifications as well as of fuel performance of fast breeders is emphasized. (auth)

52424 (A/CONF.49/P-350) RESEARCH IN FUEL ELEMENT TECHNOLOGY IN YUGOSLAVIA. Anastasijevic, P.; Pavlovic, M.; Ristic, M. M.; (and others) (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). May 1971. 16p. (CONF-710901-117). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The main results of the research and development program in ceramic fuel element technology are shown. The basic results of theoretical and experimental investigations are described in the sintering of uranium dioxide powder; welding of stainless steel and zirconium alloys; methods carried out for mechanical testing of fuel elements; thermophysical, nuclear, and hydrodynamic testing of fuel elements; methods developed for determining nuclear impurities in fuel; fuel behavior in nuclear reactor operating conditions, and determination of fuel burn up. Some new fuel element production processes with special reference to vibratory compaction are also given. On the basis of recent studies, a parametric technical and economic analysis for the construction of a plant for fuel element production is described in connection with the integration of nuclear power stations in the Yugoslav electric power system. (auth)

52425 (A/CONF.49/P-379) FABRICATION AND IRRADIATION OF PLUTONIUM-BEARING FUEL PINS FOR THERMAL AND FAST REACTORS. Hoechel, J. (Internationale Atomreaktorbau G.m.b.H., Bensberg (West Germany)); Stoll, W. (Alpha-Chemie und -Metallurgie GmbH, Wolfgang, Ger.). Jan 1971. 16p. (CONF-710901-132). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Topics discussed include design criteria specific to plutonium, fabrication techniques and process improvement, cost trends, and experience in the irradiation of plutonium-bearing fuel elements. (D.H.M.)

52426 (A/CONF.49/P-385) FUEL ELEMENTS FOR HIGH TEMPERATURE REACTORS: PRODUCTION EXPERIENCE AND IRRADIATION TESTING IN THE FEDERAL REPUBLIC OF GERMANY. Aumueller, L.; Hackstein, K. H.; Hrovat, M. (Nuklear-Chemie und-Metallurgie G.m.b.H., Wolfgang bei Hanau (West Germany)); Balthesen, E. (Kernforschungsanlage, Juelich (West Germany)). Apr 1971. 15p. (CONF-710901-208). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Systematic manufacturing and irradiation studies led to a pyrocarbon-coated 400 μm oxide particle for the THTR. For high-temperature reactors with helium turbine (HHT), which will require higher temperatures and heavy metal loadings, particles with 600 μm oxide kernel and silicon carbide interlayer were developed. Irradiation testing showed that coated particles and matrix materials as developed for AVR and THTR performed well at temperatures up to 1250°C, fast fluences up to 7.0×10^{21} n/cm^2 ($E > 0.1$ MeV), and a burnup of 160,000 MWd/t U, Th, showing good fission product retention ($R/B < 10^{-4}$), dimensional stability, and high mechanical strength. (D.H.M.)

52427 (A/CONF.49/P-490) FUEL FABRICATION PROCESSES AT SPRINGFIELDS WORKS OF THE BRITISH NUCLEAR FUELS LIMITED. Rogan, H.; Heal, T. J. (United Kingdom Atomic Energy Authority, Springfields (England). Production Group); Buck, C.; Carter, P. E. (United Kingdom Atomic Energy Authority, Risley (England). Production Group). May 1971. 11p. (CONF-710901-218). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Technical advances have been introduced into the established fuel manufacturing processes for the Mk I Gas-Cooled Reactor (Magnox), and wholly new processes have been added to the Work's facilities. The principal changes are outlined briefly and technical features of particular interest are referred to in more detail. Where appropriate, trends in efficiency and cost are indicated. The principal development has been the introduction of plants to manufacture fuel for the Mk II Gas-Cooled Reactor (A.G.R.) power stations now under construction. The new fuel plants comprise a 3,000 tonne/annum fluidized bed UF_4 to UF_6 plant, a 300 tonne/annum continuous UF_6 to ceramic-grade UO_2 plant with corresponding pelleting capacity, and a new Mk II G.C.R. canning plant of capacity 500 tonnes/annum. The design of the latter has been based on computer simulation studies of the economics of alternative plant arrangements. A rectilinear flow arrangement has been adopted which, combined with single pin processes, allows in-line stocks to be minimized and makes reasonable provision for subsequent changes arising from modifications to fuel element designs. To achieve high availability, control systems are built up of replaceable modules and provision for fault location is built in. Utilizing a new process,

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further UO_2 plant capacity is being installed to raise the total Mk II G.C.R. fuel element capacity to 500 tonnes/annum. Smaller plants for the production of Steam Generating Heavy Water and fast reactor fuel (oxide and carbide) have been built and are operating. The machining of both Mk I G.C.R. cans and Mk II G.C.R. cans and grids is now carried out at the Works, utilizing bought-in extrusions, tubing and forgings. (auth)

52428 (A/CONF.49/P-561) PROGRAMS FOR THE FABRICATION OF FUEL ELEMENTS IN ARGENTINE. **Araoz, Carlos (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). May 1971. 22p. (In Spanish). (CONF-710901-492). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Nuclear fuel fabrication for power reactors has technological and financial characteristics that allow developing countries to face it in all its aspects. The work performed with this purpose at CNEA, Argentina, since 1967 is described. The different steps of technological development, prototype fabrication and studies for industrial fabrication are shown in their present and near future state. Likewise, Pu based fuels have been included in this integral program trying to keep minimum investments for the corresponding developments. (auth)

52429 (WCAP-4167-1, pp E.1-6) PLUTONIUM DIOXIDE-URANIUM DIOXIDE PELLETS. **(Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.).**

In EEI-Westinghouse plutonium recycle demonstration program.

This specification applies to solid cylindrical plutonium dioxide fuel pellets in the sintered and ground condition and fabricated via the mechanical blend route for use in thermal nuclear power reactors. The manufacturer shall maintain a uniform standard of quality to meet all the requirements of this specification. Disposition of all deviations shall require written approval prior to use. (auth)

52430 PREPARATION AND PROPERTIES OF CARBIDES OF TRANSITION METALS IN THEIR HOMOGENEITY RANGE. **Samsonov, G. V.; Naumenko, V. Ya.; Okhremchuk, L. N. (Institut fuer Probleme der Werkstoffkunde, Kiev). Phys. Status Solidi (a); 6: No. 1, 201-11(16 Jul 1971). (In German).**

An investigation was made of the technology of obtaining Group IV and V transition metal carbides in the homogeneity range and of some properties of these carbides: lattice parameters, electrical resistivity, microhardness, thermal expansion coefficient, and electron work function. The concentration dependences of microhardness, electrical resistivity, work function, and thermal expansion coefficient of the titanium, zirconium, hafnium, and vanadium carbides are established to have practically linear character, but in the case of niobium and tantalum carbides the curves of the concentration dependences of these properties show extrema for the ratio $C/Me \simeq 0.8$ to 0.85. Changing of these properties in the homogeneity ranges is discussed in connection with the specific character of the electronic structures of the carbide phases investigated. (auth)

52431 CERMETS OF HIGH STATIC AND DYNAMIC STRENGTH. **(to Gesellschaft fuer Kernforschung mbH). British Patent 1,238,166. 7 Jul 1971. Priority date 23 May 1968, Germany.**

A method is described for fabricating cermets of high static and dynamic strength with a metal content extending uniformly in all three dimensions of from 10 to 50 vol % with the density of the metal component being 95 to 100% of the theoretical density and that of the ceramic component being 85 to 100% of the theoretical density. The ceramic particles have a diameter of 20 to 500 μm and are coated with the metal component. The particles vibrated in metallic capsules with sufficient plasticity under the vibration conditions. The capsules are compacted with the particles by isostatic pressing at pressures from 100 to 1000 kg/cm^2 and temperatures from 1000° to 1700°C to the ultimate density of the particles. These cermets are suitable for use as reactor fuel elements. (B.L.M.)

52432 PROCESS FOR THE PREPARATION OF MICROSPHERES. **Triggiani, Leonard Vincent; Stone, Irving Charles (to W. R. Grace and Co.). British Patent 1,238,775. 7 Jul 1971. Priority date 23 Apr 1968, United States.**

A process is described for producing microspheres of U and a second fissionable component, which may be ^{235}U, Th, or Pu, having a final U:O ratio of 2:1. Porous microspheres of natural or depleted UO_2 are heated in an atmosphere of a reducing gas to a temperature of 300° to 800°C for a period of 1 to 10 hr to remove at least part of any excess O present. The microspheres are then impregnated with a second fissionable component, and the impregnated microspheres are sintered at a temperature of 1000° to 2000°C for 2 to 24 hr. (B.L.M.)

52433 NATURE OF BORON CARBONITRIDE. I. CONDITIONS OF PREPARATION OF BORON CARBONITRIDE. **Kosolapova, T. Ya.; Makarenko, G. N.; Serebryakova, T. I.; (and others) (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 1, 22-6(Jan 1971).**

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 1, 27-33(Jan 1971).

A study was made of the preparation of boron carbonitride by various techniques. It is shown that the method of synthesis involving nitriding boron and carbon black in a nitrogen atmosphere at temperatures of 1800 to 2000°C yields a product corresponding to the composition BCN. Standard powder metallurgy techniques appear to be unsuitable for the production of massive boron carbonitride specimens (auth)

52434 EPITAXIAL GROWTH OF UO_2 THIN FILMS PRODUCED BY CATHODE SPUTTERING. **Navinsek, B. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). J. Nucl. Mater.; 40: No. 3, 338-40(Sep 1971).**

Thin foils of UO_2 are needed for electron microscopical investigations of radiation damage. A method is described for producing single crystal films of UO_2 by the use of a standard dc sputtering technique with a cathode from a pure reactor grade sintered UO_2 pellet. (auth)

52435 ABSORBER ELEMENT FOR NUCLEAR REACTORS. **Nickel, Hubertus (to Kernforschungsanlage Julich des Landes Nordrhein-Westfalen-eV). U. S. Patent 3,565,762. 23 Feb 1971. Priority date 26 Feb 1966, Germany.**

Multilayer spheroidal particles distributed in a graphite or Zr-alloy body comprise a generally spheroidal absorber element for a nuclear reactor. Each particle is composed of a core of a high-melting-point boride selected from the group consisting of the diborides of Zr, V, Hf, and Ta; a shell of a material selected from the group consisting of ZrO_2, SiC, ZrC, and NbC surrounding the core; and a coating of pyrolytic C sheathing the shell. (B.L.M.)

52436 PROCESS FOR MANUFACTURING HIGH DENSITY GRAPHITE. **Galy, Andre; Rolland, Pierre (to Pechiney, Compagnie de Produits Chimiques et Electrometallurgiques. Commissariat a l'Energie Atomique). French Patent 1,587,312. 9 Feb 1970. Filed 1 Jul 1964. (In French).**

A process for manufacturing graphite was developed. A compact graphite block is used as the raw material; it is covered with a layer of powdered refractory material of low electrical and thermal conductivity (e.g., carbon black powder) whose thickness does not exceed 10 per cent of the block diameter. The block is then heated to between 3100 and 3500°C and subjected to a pressure whose maximum value lies between 100 and 400 kg/cm^2. (France)

52437 POSSIBILITY OF SINTERING TUNGSTEN BORIDES WITH NICKEL. **Kiparisov, S. S.; Nikiforov, O. A.; Kuz'mina, Yu. K. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 5, 93-5(1970). (In Russian).**

The conditions governing the wetting of W_2B, WB, and W_2B_5 with molten Ni were studied in conjunction with an investigation into the possibility of producing compact sintered castings of Ni-containing borides by the direct-contact method. In the case of W_2B_5, the wetting angle fell from 25 to 16° on increasing the temperature from 1200 to 1400°C. Practical tests based on the direct-contact method confirmed the production of W-B-Ni castings with a porosity <5%. (Metals Abstr.)

Properties Evaluations

Refer also to abstracts 51672, 52318, 52430, 52954, 52966, and 54288.

52438 (BMI-1912) HIGH-TEMPERATURE CREEP OF URANIUM DIOXIDE. **Seltzer, Martin S.; Markworth, Alan J.; Clauer, Allan H.; Wilcox, Benjamin A.; Perrin, James S. (Battelle Columbus Labs., Ohio). Jul 1971. Contract W-7405-eng-92. 46p. Dep. NTIS.**

Experiments were performed to determine the influence of temperature, stress, grain size, density, and deviation from stoichiometry on the compression creep characteristics of uranium dioxide. Studies were performed using single crystals and both enriched and depleted polycrystals of UO_{2+x}, where $0.0001 < x < 0.121$. The effects of the variables investigated on the minimum creep rates are interrelated and a regression analysis was performed on the data in order to establish the equations which best describe the influence of these variables on the creep of uranium dioxide. (auth)

52439 (RISO-M-1385) SECONDARY HIGH-TEMPERATURE CREEP OF POLY-CRYSTALLINE MAGNESIUM OXIDE. Bilde-Soerensen, J. B. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jun 1971. 95p. (In Danish). Dep. NTIS (U. S. Sales Only).

A literary review of the creep properties of ceramic materials is given. Also some of the models proposed for secondary high-temperature creep are discussed. Experimentally the secondary creep of polycrystalline magnesium oxide with grain sizes of 100 and 190 μm was examined at temperatures between 1300 and 1460°C and at compressive loads between 2.5 and 5.5 kip/mm^2. The dependence of creep rate upon load follows a power law with an exponent of 3.2. The process is thermally activated with an activation energy of 76 ± 12 kcal/mole. The creep rate is independent of grain size. The total dislocation density follows the relation $G = bG\sqrt{e}$ that is commonly found for metals. The dislocation structure is a three-dimensional network which contains dislocations lying in their glide plane as well as dislocations lying in their climb plane. On the basis of this structure a model is proposed where the main contribution to the deformation comes from glide, but where the rate-limiting process is diffusion-controlled. The agreement with the experimental results is within one order of magnitude. (90 references) (auth) (Denmark)

52440 (RT/ING-71-6) GAMMA DENSITOMETRY TECHNIQUE ON IRRADIATED FUEL SAMPLES. Cesarano, C.; Cochi, C.; Sternini, E. (Comitato Nazionale Energia Nucleare, Rome (Italy)). 14 Apr 1971. 28p. Dep. NTIS (U. S. Sales Only).

An experimental technique used for determining the density distribution of irradiated cylindrical fuel pins is described. The method involves basically the same type of equipment as used for gamma scanning with a ^{60}Co source. The technique has been in use at the Cassaccia Hot Laboratory since 1968. Some results are reported and discussed. (auth)

52441 COLD-WORK PEAK IN UNDEFORMED NIOBIUM. Dahlstrom, N.; Dollins, C. C.; Wert, C. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. Acta Met.; 19: No. 9, 955-63(Sep 1971).

The internal friction spectrum of undeformed and deformed niobium—nitrogen alloys was studied around one Hz from room temperature to 700°C. The goal of the work was that of further elucidating the mechanism of the cold-work peak: in particular, examining the necessity of externally imposed deformation. Since the peak has been reported in quench-aged alloys with no external deformation, the latter possibility was examined in considerable detail. Isomal annealing experiments were performed at 535°C, the approximate temperature of the cold-work peak, to follow its development and decay. The internal friction increased rapidly with time after some delay to a maximum value whose height was dependent on the initial amount of nitrogen present. The height then decreased with further aging time. The nature of the precipitates at these various stages was determined by transmission electron microscopy. During the initial stages of nitride precipitation finely dispersed lenticular precipitates formed of size less than 500 Å. During this stage the cold-work peak had not yet developed. As the precipitates coarsened the peak grew in height and only reached its maximum when the precipitates had produced many dislocation loops and dislocation tangles. Because the precipitates in undeformed samples produced a significant dislocation density, it is concluded that a single dislocation-interstitial mechanism causes the cold-work peak in both deformed and undeformed aged samples. (auth)

52442 TENTATIVE METHOD OF TEST FOR DELTA-IN-HOURS (DIH) PURITY OF NUCLEAR GRAPHITE. ASTM C624-68T. Philadelphia; American Society for Testing and Materials (1968). 2p. Availabel from American Society for Testing and Materials, Philadelphia.

This method covers the determination of delta-in-hours (DIH) purity of nuclear graphite. This method applies to graphites to be used for moderator or reflector components of nuclear reactors and subcritical test reactors and for thermal columns. Excluded from this method are graphites containing fissionable materials for use as fuel or driver elements and graphites containing materials having high neutron absorption cross sections for use as reactor control or safety devices. The size, number of samples, and authorization required for determining DIH purity are given. (auth)

52443 TENTATIVE RECOMMENDED PRACTICE FOR REPORTING IRRADIATION RESULTS ON GRAPHITE. ASTM C625-68T. Philadelphia; American Society for Testing and Materials (1968). 2p. Available from American Society for Testing and Materials, Philadelphia.

This recommended practice covers information recommended for inclusion in reports giving graphite irradiation results. The purpose of this recommendation is to identify sample and test parameters that may influence graphite irradiation test results. This practice should not be construed as a requirement or recommendation that proprietary information be disclosed. (auth)

52444 BRITTLE-REGION SLIP SYSTEMS IN THE TRANSITION-METAL CARBIDES. Hannink, R. H. J.; Kohlstedt, D. L.; Murray, M. J. (Cavendish Lab., Cambridge, Eng.). Phys. Status Solidi (a); 6: No. 1, K25-6(16 Jul 1971).

The hardness anisotropy of TiC, VC, ZrC, and NbC single crystals was measured in order to determine the room-temperature slip systems. For TiC, the room-temperature slip system is identified as $\{110\}\ \langle 110\rangle$. The VC curve is interpreted in terms of two active slip systems, on the $\{110\}$ and $\{111\}$ planes in the $\langle 110\rangle$ directions. ZrC and NbC exhibit anisotropy similar to that of TiC and VC, respectively. (D.L.C.)

52445 HIGH TEMPERATURE HEAT CAPACITY OF URANIUM MONOSULFIDE BY THE LASER FLASH METHOD. Murabayashi, M.; Takahashi, Y.; Mukaibo, T. (Tokyo Univ.). J. Nucl. Mater.; 40: No. 3, 353-4(Sep 1971).

The high temperature heat capacity of US was measured in the temperature range between 298 and 1000°K by the laser flash method. (auth)

52446 PROPERTIES OF ZIRCONIUM CARBIDE–NIOBIUM CARBIDE ALLOYS IN THEIR HOMOGENEITY REGION. Samsonov, G. V.; Upadkhaya, G. Sh. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 2, 151-3(Feb 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 2, 85-8(Feb 1971).

A study was made of the electrical resistivity, thermo-emf, Hall coefficient, magnetic susceptibility, and temperature dependence of electrical resistivity and thermo-emf (at 50 to 1000°C) of binary solid solutions of zirconium and niobium carbides in their homogeneity region (C/Me = 0.9 : 1.0). The properties investigated exhibit extreme values at the equimolar composition, which is evidence that the Zr–Nb bond predominates in the total bond energy in the formation of solid solutions. (auth)

52447 BEHAVIOR OF BORON NITRIDE AND ALUMINUM NITRIDE PARTICLES IN A MOLYBDENUM MATRIX. Alfintseva, R. A. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 1, 65-8(Jan 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 1, 83-7(Jan 1971).

Research results show that dispersed boron nitride particles are unstable in a molybdenum matrix and at 1600°C form with the molybdenum a new solid phase of a metallic character in equilibrium with another phase, which differs only little from pure molybdenum. Dispersed aluminum nitride particles are stable in a molybdenum matrix at temperatures up to 1800°C. No reaction or formation of a new phase was observed at these temperatures. (auth)

52448 COMPRESSIBILITY OF MOLTEN UO_2. Slagle, O. D.; Nelson, R. P. (Hanford Engineering Development Lab., Richland, Wash.). Contracts AT(45-1)-1830; AT(45-1)-2170. J. Nucl. Mater.; 40: No. 3, 349-50(Sep 1971).

Values of compressibility determined on molten UO_2 in the temperature range from 2865 to 2923°C are reported. The compressibility was determined from measurements of the velocity of ultrasonic waves by means of the phase comparison technique using an apparatus described elsewhere. (auth)

52449 MICROHARDNESS ANISOTROPY IN POLYCRYSTALLINE CARBIDES OF THE TRANSITION METALS OF GROUP VI. Koval'chenko, M. S.; Rogovoi, Yu. I. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 2, 157-62(Feb 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 2, 93-9(Feb 1971).

Using the technique of hardness measurements with a square-based diamond indentor, microhardness-distribution curves were obtained for polycrystalline specimens of refractory carbides. The resulting microhardness-distribution data were employed for determining the degree of microhardness anisotropy in carbides of the transition metals of group VI. The highest values of microhardness are found on the end faces of hot-pressed specimens, which is attributable to texture formation. For fused carbides, the anisotropy of microhardness is less, while the frequency curve of Mo_2C is shifted toward higher microhardness values. On the end faces of specimens, the grains of compounds with the Mo_2C structure are likely to arrange themselves so

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that their $(2\bar{1}\bar{1}0)$ and $(10\bar{1}2)$ planes (hot-pressed specimens) or $(10\bar{1}2)$ planes (fused specimens) lie on the surface. The character of microhardness-distribution curves and their variation for the compounds investigated are linked with the crystallographic factors involved in the plastic deformation of carbides. (auth)

52450 TECHNICAL ALLOYS OF THE SYSTEM ZrB_2–ZrN. Medvedeva, O. A. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 1, 27-9(Jan 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 1, 34-7(Jan 1971).

An investigation was conducted on the preparation of alloys of the system zirconium diboride–zirconium nitride by hot-pressing. It was established that the solubility of zirconium nitride in zirconium diboride is 2 mol %, while the solubility of the diboride in the nitride is 5 mol %. (auth)

52451 TUGOPLAVKIE KARBIDY. (Refractory Carbides). Samsonov, G. V. (ed.). Kiev; Naukova Dumka (1970). 276p.

Methods of producing carbides and articles made from carbides are described, chiefly of the transitional metals of Periodic Table Groups IV through VI. The properties of some pyrolytic carbides of B, Zr, and Ti, metalloceramics based on Ti carbide, Nb powders and coatings, and the carbohydrides of Ti, V, and Nb, are the subjects for one group of articles. Several papers discuss phase equilibria diagrams for systems such as: Ti–Mo–C, Ta–V–C, and Nb–Re–C. Papers on highly porous (to 74%) transition metal carbides, as well as non-porous polycrystalline silicon carbide, are included. Carbide structure is discussed in a few articles: several compounds of Nb and C, the state of the C atom in the carbides of the transition metals, the structure of Ti carbide, V carbide, and Cr carbide. The thermochemical aspects of the carbides are examined, particularly for Ti, Nb, Zr, Mn, Si, and Ta, accompanied by related properties, as homogeneity, enthalpy, entropy, heat capacity, and the dependence of these on temperature. Microhardness of the transition metal carbides, their hot hardness, abrasive wearability, stability toward erosion, external friction of refractory carbides, and their specific electrical resistance at high temperatures, are discussed. Finally, a few papers are concerned with the chemical interaction of transition metal carbides with other substances: refractory oxides, carbonitrides, Mo, W, steels and cast irons, and ZrO_2. Each of the 56 papers is accompanied by its literature references. (K.S.W.)

52452 THERMAL EXPANSION OF URANIUM AND TANTALUM MONOCARBIDES UP TO 2700°C. Richards, Hans K. (Argonne National Lab., Ill.). Nucl. Technol.; 10: No. 1, 54-61(Jan 1971).

Data are reported from experiments performed to measure thermal expansion of uranium carbide up to the melting point, the expansion accompanying the transition from solid to liquid, and thermal expansion in the liquid phase. The thermal expansion of the tantalum carbide crucibles, used to hold the uranium carbide specimens, was also measured. Experiments were performed using a high-temperature, helium-atmosphere, tungsten filament furnace. Compatibility tests showed that tungsten-graphite and tungsten-tantalum carbide pairs fused together at approximately 2400°C; tantalum carbide and graphite remained compatible to 2800°C over the time scale necessary for the expansion measurements. Changes in the length of each expansion sample were measured by detecting electrical contact between the sample and a graphite rod. For measurements in which the uranium carbide was molten, a tantalum carbide disk was placed at the end of the graphite rod to prevent attack of the sensing rod by the molten uranium carbide. Melting point of the uranium carbide samples was 2550°C. The average UC linear thermal expansion from room temperature to the melting point is 17×10^{-6}/°C. Volume expansion upon melting of UC is 11.4%. A provisional linear thermal expansion of 35.2×10^{-6}/°C was measured for molten UC thermal expansion between 2650 and 2740°C. (auth)

Structure and Phase Studies

Refer also to abstract 52378.

52453 (CONF-711001–(Vol.2), pp 598-609) NONSTOICHIOMETRY OF RARE EARTH HEXABORIDES. Yajima, S.; Niihara, K. (Tohoku Univ., Sendai (Japan). Research Inst. for Iron, Steel and Other Metals). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

A study was made of the nonstoichiometric properties of the hexaborides of Ce, Pr, Sm, Gd, and Tb. The effects of preparation conditions on the nonstoichiometry were examined, especially for SmB_6. Lattice parameter, density, and electric resistivity were measured. The wide homogeneity range is explained in terms of the electronic configuration. A ternary boride, YCo_2B_2, was prepared and its structure determined. (D.L.C.)

52454 (CONF-711001–(Vol.2), pp 631-7) PHASE RELATIONSHIPS IN THE TERNARY SYSTEM $PrO_x - ZrO_2$. Brauer, G.; Willaredt, B. (Freiburg Univ. (West Germany)). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

A study was made of the effect of oxygen pressure on the phase relationships in $PrO_x - ZrO_2$ mixtures during their preparation. The mixtures were subjected to the following treatments: (1) heating for several hr at 500°C under 130–150 atm O_2; (2) heating to 500°C in air; and (3) reduction by H_2 at 700°C. Four phases were observed, and the lattice parameters and oxidation states were measured. A plot of lattice parameter vs composition is presented, and it is concluded that the addition of ZrO_2 to PrO_2 does not promote the oxidation of Pr, but rather expands the host lattice. Only at higher ZrO_2 contents does the lattice parameter decrease as predicted. (D.L.C.)

52455 (CONF-711001–(Vol.2), pp 764-74) PROBLEM OF THE STABILITY OF THE Eu^{3+}-TRANSITION METAL OXIDES AS ILLUSTRATED BY THE SYSTEM Eu–Fe–O. McCarthy, Gregory J.; Fischer, Rose D. (Pennsylvania State Univ., University Park. Materials Research Lab.). 1971

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Compound formation and phase relations at 1200°C have been studied for the $EuO-Eu_2O_3-Fe_2O_3-Fe$ portion of the system Eu–Fe–O. Only two ternary compounds, in both of which the europium was trivalent, could be prepared over the temperature range 1100 to 1400°C. The existence of seven ternary compounds containing divalent europium is predicted by the crystal chemical analogy of Eu^{2+} and Sr^{2+} compounds, but none of these could be prepared. Divalent europium was found not to be stable in any phase assemblage with trivalent iron. This result is consistent with simple oxidation-reduction thermodynamics. The problem of predicting compound formation in ternary oxide systems with variable valence cations is discussed with respect to these results. (auth)

52456 (CONF-711001–(Vol.2), pp 777-85) PHASE TRANSFORMATIONS IN RARE EARTH OXIDE THIN FILMS. Boulesteix, C. (Paris Univ., Orsay (France). Institut d'Optique); Caro, P. E.; Gasgnier, M.; La Blanchetais, Ch. Henry; Schiffmacher, G. (Centre National de la Recherche Scientifique, Bellevue (France). Laboratoire des Terres Rares). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Rare earth oxide thin films are produced by oxidation of rare earth metal thin films. C-type Ln_2O_3 is obtained for all rare earths, even for lanthanum. The C-type is recrystallized into the high-temperature phases A or $B-Ln_2O_3$ by heating in the electron microscope. $A-Ln_2O_3$ is observed for La, Pr, and Nd. The c hexagonal axis is perpendicular to the plane of the films which is consequently parallel to the $(LnO)_n^{n+}$ group basal planes as was observed for $B-Ln_2O_3$ (A and $B-Ln_2O_3 = (LnO)_2O$). Short-lived domains of $B-Pr_2O_3$ and $B-Nd_2O_3$ can be produced by inducing thermal stress in the A-type films. The epitaxial relationship between the two phases is determined; the B to A transition has a martensitic character. (auth)

52457 (RT/CHI–(70)36) GROWTH OF CRYSTALS IN THORIUM OXIDE GEL. Bazzan, T.; Cabrini, T. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 21 Oct 1970. 24p. (In Italian). Dep. NTIS (U. S. Sales Only).

Studies to investigate the grain growth kinetic process in thoria gels are described. The experimentally derived kinetic law is $D^3 - D_0^3 = Kt\, e^{-Q/RT}$ with a Q value of 1.67 eV and a prevailing diffusive mechanism. At 1200°C the gel density is almost the theoretical one. (auth)

52458 RECRYSTALLIZATION BEHAVIOR OF A THORIUM OXIDE-DISPERSION-HARDENED TUNGSTEN–RHENIUM ALLOY IN COMPARISON WITH PURE TUNGSTEN. Majdic, M.; Wirth, G. (Institut fuer Werkstoff-Forschung, Porz-Wahn, Ger.). J. Less-Common Metals; 24: No. 4, 341-67(Aug 1971). (In German).

The recrystallization behavior of $W-3Re-2ThO_2$ was compared with undoped tungsten, both materials being produced by powder metallurgical methods. Specimens of different degrees of cold working were investigated by x-ray diffraction, hardness tests, metallographic, and electron microscopic methods after annealing for one hour in the temperature range between 1000 and 2400°C. The results show that the threshold of the alloy compared with tungsten is shifted to higher temperatures for about 100 to 400°C, depending on the degree of cold working. The secondary recrystallization observed in tungsten does not occur in the alloy at the same temperatures. Primary recrystallization in tungsten seems to be a grain boundary migration for small degrees of cold working. But, in the case of larger deformations, it is initiated by a nucleation process. Recrystallized grains in the alloy are extended in the rolling direction parallel to the strings of particles. The results are summarized in a recrystallization diagram for both materials. Loss of shape stability of the ThO_2 particles occurred after annealing for one hour at 2400, and at 2200°C after longer annealing times. The effects of these particles on the recrystallization behavior were evident in all cases. (auth)

52459 LIQUIDUS DETERMINATIONS ALONG BINARY AND PSEUDO-BINARY SUB-SYSTEMS WITHIN THE QUATERNARY SYSTEM $CaO–Nb_2O_5–TiO_2–SiO_2$. Jongejan, A.; Wilkins, A. L. (Dept. of Energy, Mines, and Resources, Ottawa). J. Less-Common Metals; 24: No. 4, 445-52(Aug 1971).

Liquidus curves of binary and pseudo-binary sub-systems of the quaternary system $CaO-Nb_2O_5-TiO_2-SiO_2$ have been determined using the customary quench technique as well as hot-stage microscopy. Results of studies are included on niocalite ($10CaO \cdot Nb_2O_5 \cdot 6SiO_2$)–perovskite ($CaO \cdot TiO_2$), $CaO \cdot Nb_2O_5$–sphene ($CaO \cdot TiO_2 \cdot SiO_2$), sphene–pyrochlore ($3CaO \cdot Nb_2O_5 \cdot 3TiO_2$), $8CaO \cdot 7Nb_2O_5 \cdot 6TiO_2$–sphene and $8CaO \cdot 7Nb_2O_5 \cdot 6TiO_2-SiO_2$. The shape of the curves indicated that only the system niocalite–perovskite was a true binary system and the others were pseudo-binary systems. (auth)

52460 PHASE EQUILIBRIA IN THE SYSTEMS VANADIUM–MANGANESE–BORON, MOLYBDENUM–MANGANESE–BORON, AND TUNGSTEN–MANGANESE–BORON. Telegus, V. S.; Kuz'ma, Yu. B. (Lvov State Univ.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 10: No. 1, 52-6(Jan 1971).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 10: No. 1, 67-72(Jan 1971).

The results of an investigation of the phase equilibria in the systems V–Mn–B, Mo–Mn–B, and W–Mn–B, which have not yet been described in the literature are presented. The only known fact is the existence of the ternary phases $(Mo, Mn)_3B_2$ and $(W, N)_3B_2$, having a tetragonal U_3Si_2-type structure. (auth)

52461 APPLICATION OF LATTICE CONSTANT MEASUREMENTS FOR STOICHIOMETRY DETERMINATION IN IRRADIATED U–Pu MIXED OXIDE FUELS. Schmitz, F.; Dean, G.; Halachmy, M. (CEN, Fontenay-aux-Roses, France). J. Nucl. Mater.; 40: No. 3, 325-37(Sep 1971).

A method is proposed for determining the oxygen/metal ratio in mixed irradiated uranium–plutonium oxides. The method is based on a measurement of the lattice constants and on a standard thermal treatment which is used to obtain a tetravalent state of uranium and plutonium. The effects of irradiation and of the solution of solid fission products in the matrix, the variation in plutonium concentration, and influence of these factors on stoichiometry are discussed on the basis of the results of simulated experiments in which the state after irradiation of oxide fuels is computed, together with the concentrations of the fission products. For a given burn-up τ the oxygen/metal ratio of the matrix O/U + Pu + FP, which has a considerable influence on the physical properties of the fuel, is obtained by direct measurement of the ratio O/U + Pu and correcting this value for the effect of soluble fission products using the equation: $O/U + Pu + F.P. = 3/(3 - \tau) \{[(1 - \tau)O/U + Pu] + [{}^2\!/_3 \tau \cdot 1.75]\}$. (auth)

52462 DISLOCATION MECHANISMS FOR NUCLEATION OF TRANSFORMATIONS IN VANADIUM CARBIDE. Billingham, J.; Lewis, M. H. (Univ. of Warwick, Coventry, Eng.). Phil. Mag.; 24: No. 188, 231-40(Aug 1971).

An electron microscope study indicated that large intrinsic stacking faults are formed in the cubic structured vanadium carbide at compositions close to the $VC-V_2C$ phase boundary. It is proposed that these faults, bounded by Shockley partial dislocations, provide the nuclei for a transformation of the cubic carbide to the hexagonal V_2C or ζ phases which occurs at slightly lower carbon concentrations. (auth) (UK)

52463 REDISTRIBUTION OF URANIUM AND PLUTONIUM DURING EVAPORATION PROCESSES IN MIXED OXIDE FUEL. Bober, M.; Sari, C.; Schumacher, G. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater.; 40: No. 3, 341-5(Sep 1971).

Evaporation experiments performed with oxide fuel containing 15 mole % of plutonium oxide showed that at the temperatures prevailing in the center of reactor fuel elements congruent evaporation of uranium and plutonium oxides takes place for an O/M ratio between 1.96 and 1.97. If the O/M ratio is greater than 1.97, preferential evaporation of uranium oxides causes plutonium enrichment in the neighborhood of the central cavity. Redistribution through thermal diffusion has the same effect. On the other hand, if the O/M ratio is smaller than 1.96, the preferential evaporation of plutonium oxide causes uranium enrichment in the center. There is no redistribution when the O/M ratio in the fuel corresponds to the ratio giving congruent evaporation rates which lies between 1.96 and 1.97. Contrary to thermal diffusion which is a typical long-term effect, redistribution by evaporation and condensation substantially takes place within a few hours. This contributes largely to the redistribution in the initial phase when columnar grains are formed. Therefore, the redistribution effect must be anticipated from the outset in a reactor fuel element. In a stoichiometric fuel, plutonium enrichment in the center of the fuel element reaches such a high level after a short period of irradiation (up to about 30% above the initial concentration) that the central temperature increases by up to about 100°C. This increase in temperature must be taken into account in reactor design, the more so, since a further increase in the central temperature must be anticipated as a result of progressive redistribution by thermal diffusion. (auth)

52464 KINETICS OF U_3Si FORMATION IN CAST U_3Si ALLOY. Kimmel, G.; Tomer, A.; Bar-Or, A. (Nuclear Research Centre, Beer-Sheva, Israel). J. Nucl. Mater.; 40: No. 3, 242-8(Sep 1971).

The growth of U_3Si in cast U-3.8 wt % Si alloy was measured by determining both the U_3Si_2/U_3Si interface movement, and the change in the total amount of the various phases. The activation energy controlling growth was found to be 50 ± 1 kcal/mole. (auth)

Radiation Effects

Refer also to abstracts 52392, 52899, 52903, 54086, 54096, 54110, 54193, 54286, and 54289.

52465 (A/CONF.49/P–245) RADIATION DAMAGE STUDIES OF GRAPHITE IN JAPAN. Nagasaki, R.; Honda, T.; Iwata, T. (Japan Atomic Energy Research Inst., Tokyo). May 1971. 24p. (CONF-710901–95). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Tests of graphite moderators used in the Tokai Nuclear Power Station (Japan) carried out over several years to assure safety of its reactor are described. At the same time, a series of basic research activities also have been conducted to clarify the fundamental process of radiation damage in graphite. Taking in account the peculiar conditions of the Tokai site, the following five items were adopted for monitoring: dimensional change, oxidation weight loss, stored energy, thermal conductivity change, and mechanical strength change. The results obtained until now coincide fairly well with data anticipated in initially designing the reactor, and they sufficiently ensure safety of the reactor for the present. Fundamental processes are divided into the atomic displacement process and the thermal annealing processing of defects. Information concerning atomic displacement has been used in calculating the damage function. From relatively systematic experiments, the directional dependence of threshold energy for displacements and the displacement cascade process were determinable at three different temperatures. Regarding thermal annealing, the electrical resistivity, galvanomagnetic effect, and stored energy were measured at temperature ranges between 6 and 600°K, and the annealing stages were tentatively specified. (auth)

52466 (A/CONF.49/P–339) IRRADIATION BEHAVIOUR OF VITROCERAMIC NUCLEAR FUEL. Lungu, S.; Alecu, I. D.; Glanz, G.; Rutter, I. (Institute for Atomic Physics, Bucharest (Romania)). May 1971. 20p. (CONF-710901–204). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The latest results of the irradiation experiments and the corresponding specialized irradiation equipment are presented. The data reported refer particularly to: curves of volume changes at temperatures between 500 to 1600°C and burnup values up to about 5000 MWd/t; in-reactor creep curves for uniaxial stresses of 0 to 200 kgf/cm^2 and low ratings; and preliminary tests on gaseous fission product release through aluminum silicate coatings, and irradiation behavior of these. The most interesting result was a swelling effect at high temperatures which saturated after about 200 MWd/t, but occurred again as a result of a change in temperature, bringing the specific volume to another corresponding equilibrium value. This phenomenon was analyzed together with the common temperature irradiation data. In this analysis the in-reactor creep data were also used. The results of the experi-

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ments proved that the in-reactor creep observed was a pure irradiation effect and the creep rate was linearly dependent on the applied stress and rating. An estimation of the total creep strain of a typical vitroceramic fuel element is attempted by extrapolating the present data. Finally, the irradiation program and the means of its accomplishment are considered. (auth)

52467 (A/CONF.49/P-452) PROPERTIES AND BEHAVIOUR OF MODERATOR MATERIALS UNDER IRRADIATION. Andriyevskii, R. A.; Bykov, V. N.; Klimenkov, V. N.; Kovyrshin, V. G.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 33p. (CONF-710901-387). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Properties and behavior of graphite, beryllium, beryllium oxide, and zirconium hydride used as moderators in power and research reactors were examined. Effects of radiation on different types of graphite in a broad range of temperatures and integrated fluxes (150 to 1000°C, 10^{20} to 10^{22} n/cm^2) are reviewed. Changes of the physical and mechanical properties of graphites having different structure, anisotropy, and lattices are analyzed. Graphite property changes under irradiation as far as all possible mechanisms of radiation damages are correlated. The criteria for graphite cladding stability are discussed. The results of considerable Be and BeO damages due to the radiation effect at low temperatures are treated. The temperature limits and integrated fast neutron fluxes within allowable ranges that change Be and BeO properties were determined. Differences of property changes (especially in density and gas release) of Be irradiated at high temperature (ranging to 1000°C) and annealed at low temperature are emphasized. Zirconium hydride properties and their structural defects that effect its physical and mechanical properties are described. The method and the results of out-of-pile investigations in the processing of equilibrium hydrogen pressure irradiation in a broad temperature interval are given. Effects of irradiation on hydrogen yield, thermo- and electroconductivity, and zirconium hydride structures were investigated. The results are given of the effect of radiation on macroscopic scattering cross section. (auth)

52468 (A/CONF.49/P-454) PROPERTIES AND IRRADIATION BEHAVIOUR OF CARBIDE, NITRIDE, PHOSPHIDE, AND OTHER FUEL COMPOSITIONS. Menshikova, T. S.; Reshetnikov, F. G.; Rymashevskii, G. A.; Lebedev, I. G.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 32p. (CONF-710901-472). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Available techniques for obtaining uranium and plutonium carbides, nitrides, phosphides and sulphides are given as well as methods for producing bars from the compounds. Results are presented on studies of the thermodynamic properties, electric conductivity, thermal conductivity, linear expansion coefficient, modulus of elasticity, strength characteristics, heat resistance of these compounds within a wide temperature range (up to 2000°C). The data obtained on physical-chemical and thermal-physical properties are discussed and compared. The results are presented of a study of the compatibility of fuel compositions both in the direct contact with structural materials and via a sodium- or helium gap. Irradiation testing results are reported for uranium carbide fuel elements. (auth)

52469 (A/CONF.49/P-503) STUDIES OF IRRADIATION DAMAGE IN CARBONS AND GRAPHITES APPROPRIATE TO MK II GAS COOLED REACTORS (A.G.R.'s) AND TO MK III GAS COOLED REACTORS (H.T.R.'s). Kelly, B. T. (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group); Simmons, J. H. W. (Atomic Energy Research Establishment, Harwell (England)); Nettley, P. T. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group); Gittus, J. H. (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group). May 1971. 14p. (CONF-710901-155). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The standard UK moderator graphite used in the Mk I Gas-Cooled Reactors (Magnox) exhibits large anisotropic dimensional changes when irradiated at the temperatures and fast-neutron doses appropriate to Mk II Gas-Cooled Reactors (AGR). Isotropic graphites with improved dimensional stability under irradiation were developed for this system. Irradiation experiments carried out in the high flux Dounreay Fast Reactor and the BR-2 Reactor provided data on the behavior of these materials over the full range of dose, irradiation temperature, stress, and radiolytic oxidation level necessary for reactor design. The results are presented of measurements of dimensional changes, physical properties, mechanical properties, and irradiation creep. The application of these results to the neutron spectrum appropriate to the power reactor and corrections for flux level effects are described. These studies were extended to the higher temperatures of the Mk III Gas-Cooled Reactor (HTR). The Dounreay Fast Reactor was used to provide data on the behavior of model fuel compacts, moderator and fuel tube graphites for this system. Information is presented on the physical and mechanical properties and dimensional changes of these materials. (auth)

52470 (A/CONF.49/P-614) EXPERIMENTS ON CREEP IN GRAPHITE UNDER NEUTRON IRRADIATION. Axelrad, C.; DuPont, G. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires); Jouquet, G.; Patarin, L. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1971. 12p. (In French). (CONF-710901-254). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The knowledge of creep phenomena in graphite under radiation is often necessary for the technology of reactors using this material. In fact the neutron flux and temperature distribution in graphite can cause size variation gradients responsible for the development of stresses, which can be prohibitive if not partially relaxed by creep. In a general context one of the problems of concern to the CEA has been the buckling of the rods of a stack under a transverse flux gradient. Several experiments were carried out using fairly large graphite tubes; models of actual rods. The irradiation devices were designed so as to allow or oppose free buckling of the tube. In the former case, the amount of bending may be calculated by a simple relationship similar to that describing the effect of a heat gradient. In the latter case the creep parameters which govern the behavior of the tube can be deduced from its relaxation after the experiment. In any case these tests must be correlated by a direct measurement of the creep under constant stress, and an experiment was designed for this purpose. It enabled the deformation of a test piece subjected to a simple compression or a tensile stress to be observed continuously during irradiation, and compared with a non-loaded reference sample. This measurement was carried out by means of a device free from the drifts and perturbations connected with in-pile operation. The use of this apparatus provided precise information on the phenomena of transitory and linear creep, the conditions of recovery with no load and under flux, and the numerical creep coefficient values of the graphite tested. (auth)

52471 (A/CONF.49/P-707) STUDY OF CARBIDE FUEL ELEMENTS. Ladygin, A. Ya.; Efimov, I. A.; Likhatchev, Yu. I.; Aleksandrov, Yu. I.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 34p. (CONF-710901-417). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The results of pre-irradiation, irradiation, and post-irradiation tests of uranium monocarbide fuel assemblies having 1 to 5% burnup of fissile atoms are presented. Each assembly contains six fuel elements positioned in a hexagonal container in which the sodium coolant is circulating. The bar-type fuel element is filled with pellets of uranium monocarbide. The interior cavity of the fuel element is filled with helium. Uranium monocarbide containing 4.8 to 5.4 wt % of carbon was prepared by a carbothermic vacuum reduction of uranium dioxide. Compact fuel pellets were fabricated by cold pressing followed by sintering. The fuel elements operated for about 25,000 hr, which is equivalent to more than 800 effective days. The uranium burnup during this period exceeded 50,000 MWd/t. The checking of the fuel elements for tightness showed that only the fuel elements coated with OKh18N9T steel were not tight. It was shown that changes in the fuel element diameters depend on the burnup degree and on the gap between the core and the can. Volumetric swelling of the fuel, determined by a hydrostatic weighing technique, makes up 1.5 to 3% burnup. The composition absorbs up to 93 to 98% of gas released due to fission. The migration of krypton-85 and solid fission products along the fuel element height was not observed. With the burnup increase the amount of dicarbide constituent in uranium carbide decreases, which results in the increase in the quantity of free carbon. The inner and outer surfaces of the element cans showed the interaction layers differing from each other in their appearances and formation conditions. It was demonstrated, that in the case of long storage of the fuel elements in air (after removal from the reactor) the cans corrode and become completely damaged. The can material undergoes embrittlement. An evaluation is given of the fuel element can working ability for the cases when the gap between the fuel and the can is maintained during the whole service life or when it is not maintained. An analysis is given of the reasons causing damage to the fuel elements. (auth)

52472 (EUR-4347) IRRADIATION OF MIXED URANIUM AND PLUTONIUM CARBIDE AND NITRIDE FUELS IN THE FAST NEUTRON LOOP "MFBS". Mikailoff, Hubert; Leclere, Jacques; Kryger, Bernard; Bloch, Jacqueline; Conte, Madeleine (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1970. 92p. (In French). (CEA-N-1186). Dep. NTIS (U. S. Sales Only).

A description is given, together with results of two irradiation experiments carried out on mixed-carbide and nitride type fuels. The experiments were done in the fast neutron loop "MFBS", designed by the Mol Nuclear Research Center. In the first experiment, four small sodium-bonded fuel elements (mixed-carbide, nitride, carbo-nitride and alloyed carbide) were tested. The linear power ranged from 1700 to 2400 W/cm and the burnup from 12,500 to 16,000 MWd/t. In the second experiment, the behavior of mixed-carbide and nitride clad with helium and sodium bonds and irradiated under particularly severe thermal conditions, has been examined (heat flux: 1000 W/cm^2; maximum linear power: 3300 W/cm; maximum temperature in nitride fuel: 2500°C). The experiment lasted for only a short length of time (~8 hours) and did not involve any thermal cycling. (auth)

52473 (JPRS-53800, pp 188-95) ELECTRON MICROSCOPIC STUDY OF POROSITY IN IRRADIATED UO_2, PuO_2, AND (0.2 Pu-0.8 U)O_2. Votinova, V. V.; Gromov, V. I.; Kuz'min, V. I.; Lebedev, I. G. Translated from pp 158-64 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

Replicas of irradiated sintered briquets of UO_2, PuO_2, and 0.2 PuO_2 – 0.8 UO_2 were examined for burnups to 14.6%. The size and distribution of the pores were determined. The effects of the irradiation temperature were studied. (D.L.C.)

52474 (JPRS-53800, pp 196-204) BEHAVIOR OF GAS IN DIFFERENT TEMPERATURE ZONES OF CORE OF OXIDE FUEL. Lebedev, I. G.; Kuz'min, V. I. Translated from pp 164-70 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A study was made, on the basis of porosity and bubble behavior in fuels, of the mechanisms of swelling and gas generation in oxide fuel with respect to operation in fast reactors. The different temperature zones of the fuel are considered. It was concluded that: the major process which determines the gas generation and swelling is the migration of forming gas pores; the swelling occurs mainly due to coalescence of gas bubbles during their travel under the temperature gradient; the curve of swelling vs temperature has a maximum in the range 0.5 to 0.55 T_{melt}; and the increase in gas generation with burnup below 0.55 T_{melt} is due to increase in open porosity from swelling. (D.L.C.)

52475 (JPRS-53800, pp 280-91) FORMATION OF POROSITY IN IRRADIATED BERYLLIUM OXIDE DURING ANNEALING. Khudyakov, A. V.; Klimenkov, V. I. Translated from pp 231-40 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

BeO was irradiated by 6 × 10^{20} cm^{-2} (>1 MeV) at 100°C to produce He atoms and then annealed at temperatures up to 1500°C. The pore formation was studied by optical and electron microscopy. Thus, the process of forming He pores during high-temperature irradiation was modeled. The most favorable conditions for the use of BeO in reactors should be at irradiation temperatures of 900 to 1000°C. (D.L.C.)

52476 (JPRS-53800, pp 292-306) RADIATION DAMAGE OF VARIOUS TYPES OF ARTIFICIAL GRAPHITES. Klimenkov, V. I.; Virgil'ev, Yu. S.; Khudyakov, A. V.; Kalyagina, I. P.; Timchenko, R. A.; Shurshakova, T. N. Translated from pp 240-53 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

Graphites (recrystallized, GMZ, GMZ – pyrocarbon, resin-impregnated GMZ, and pyrocarbon) were irradiated in ampoules at fast fluxes up to 7 × 10^{21} cm^{-2} and temperatures from 100 to 1200°C. Dimensions and lattice parameters were measured. The results agree with the Simmons thermodynamic model for a highly perfect material, but not for a multicomponent material. (D.L.C.)

52477 (JPRS-53800, pp 307-13) INFLUENCE OF NEUTRON IRRADIATION ON THE PROPERTIES OF SAMARIUM HEXABORIDE. Gol'tsev, V. P.; Guseva, T. M.; Kosenkov, V. M.; Ol'khovikov, V. A.; Ponomarev, V. I. Translated from pp 253-8 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

Hot-pressed SmB_6 was irradiated by a fast neutron fluence of 10^{22} cm^{-2}. Metallographic and x-ray analyses were carried out, and the strength and volume changes were measured. The formation of He from the $^{10}B(n,\alpha)$ reaction is discussed. (D.L.C.)

52478 THERMAL CONDUCTIVITY OF SINTERED URANIUM DIOXIDE DURING IRRADIATION IN REACTOR. Magdalena, Avram (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 5, 509-15(1971). (In Rumanian).

In the technological process of nuclear fuels, their properties as well as their changes in the radiation field of the reactor play a prominent part. In literature one finds a great number of studies of the change of the thermal conductivity of the sintered uranium dioxide during irradiation in the reactor, with the temperature, burnup, and intense reactor radiation. (auth)

52479 ANNEALING OF DAMAGE IN U_3Si: ELECTRICAL RESISTIVITY STUDIES. MacEwan, J. R.; Meadowcroft, R. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater.; 40: No. 3, 311-24(Sep 1971).

The annealing of damage in quenched and in irradiated samples of U_3Si was studied by measuring changes in electrical resistivity at 4.2°K. No significant changes in resistivity were introduced by quenching from temperatures just below and from above the allotropic transformation from tetragonal to cubic at 760°C. Large increases in electrical resistivity were caused by irradiation below 100°C to produce either the disordered cubic or amorphous structures. While all the damage annealed by 600°C, there were distinct differences in annealing behavior of cubic and amorphous samples. The kinetics of each annealing stage was identified and discussed making reference to the results of similar studies based on electron microscopy, density and x-ray diffraction techniques. (auth)

52480 RECOVERY OF MECHANICAL PROPERTIES OF IRRADIATED BERYLLIUM OXIDE. Veevers, K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Nucl. Mater.; 40: No. 3, 289-96(Sep 1971).

A study of the recovery of mechanical properties of irradiated beryllium oxide by post-irradiation annealing in the range 500 to 1400°C is described. In general, the recovery of strength increased with annealing temperature and time. By annealing microcracked BeO for 1 hr at 1400°C about 70 per cent of the pre-irradiation strength was recovered. By intermediate annealing for 12 hr at 1050°C, the lifetime of the fine grained ($\leq$5 μm) BeO was increased from 2.8 × 10^{20} to 7.0 × 10^{20} nvt during irradiation at <100°C without any deterioration of mechanical properties. A theory of crack healing is proposed whereby the tips of microcracks are blunted by surface diffusion, resulting in a lowering of the stress concentration factor at the crack tip. (auth)

52481 PREDICTION OF THE IRRADIATION PERFORMANCE OF COATED PARTICLE FUELS BY MEANS OF STRESS-ANALYSIS MODELS. Kaae, J. L.; Stevens, D. W.; Luby, C. S. (Gulf General Atomic, Inc., San Diego, Calif.). Nucl. Technol.; 10: No. 1, 44-53(Jan 1971).

Three mathematical models for use in calculating the stresses and displacements in two-, three-, and four-layer pyrolytic carbon and silicon carbide coatings on microspheres of (Th,U)C_2 or (Th,U)O_2 during reactor service have been previously described. In these models it is assumed that pyrolytic carbon changes dimensions anisotropically and will creep under fast-neutron irradiation, silicon carbide is dimensionally stable and undergoes no creep, and an internal pressure is generated due to gaseous fission products. Comparison of the results predicted by these mathematical models with irradiation tests show agreement with diametral changes of two-layer fuel particles. Coating failure, presumably due to stress, occurred only in those samples with high calculated stresses. (auth)

52482 IONIZING RADIATION EFFECTS IN LITHIUM NIOBATE. Primak, William; Anderson, T. T.; Halverson, S. L. (Argonne National Lab., Ill.). Nucl. Technol.; 10: No. 1, 76-84 (Jan 1971).

Techniques for accelerated ionizing-radiation testing utilizing electrons from a Van de Graaff generator are described and applied to lithium niobate. A broad optical absorption band of small optical density (<0.1/mm) developed from the middle of the visible to the ultraviolet cut-off. Small dilatations (~10^{-5}) occurred, in some specimens positive, in others negative. Small changes were seen in the electro-acoustical properties: –7% in electro-mechanical coupling coefficient, –6% in electrical permittivity, and a slight decrease in mode purity. These changes annealed partially at room temperature over a period of several weeks. Further annealing occurred on heating for 15 minute intervals at 100°C and 140°C; annealing was completed after a heating at 180°C. These effects may be associated with storage of charge in a piezoelectric material. A crystal plate was operated effectively as a piezoelectric acoustical sensor during electron bombardment even at a dose rate 10^5R/sec but showed a small decrease in signal to noise ratio. The duration of these irradiations shows that no significant radiation damage caused by ioniza-

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tion will accumulate in a century of immersion in coolant sodium in a fast breeder reactor. The lithium niobate is extremely stable toward radiation, behaving like the close packed oxides (e.g., sapphire), rather than as a salt. (auth)

52483 RADIATION DAMAGE IN MAGNESIUM OXIDE. II. EFFECT OF PRE-IRRADIATION ANNEALING IN HYDROGEN. **Henderson, B.** (Univ. of Keele, Eng.); Bowen, D. H.; Briggs, A.; King, R. D. J. Phys., C (London); 4: No. 12, 1496-1504(Aug 1971).

When MgO crystals are subjected to reactor irradiation after annealing in hydrogen, large differences in the colour centre concentration are observed compared with unannealed crystals. These are believed to be due to vacancies diffusing to large lenticular voids produced in MgO crystals by the annealing treatment. Thus for doses less than 10^{19} nvt there is an excess of interstitial defects over vacancies which leads to an inequality between the growth of the macroscopic and unit-cell dimensions of the crystals. Detailed analysis of the changes in defect concentration, lattice parameter and density gives an estimated volume contraction per single vacancy of the order of 1 atomic volume. The formation of F_c^+ centre/cation vacancy pairs (F_c^+ centres) on annealing below 550°C proceeds with an activation energy of only 0.96 ± 0.2 eV. Since this is much lower than the activation energy for cation vacancies to migrate, it is suggested that this corresponds to the activation energy for the aggregation of close pairs of defects. Annealing characteristics at high temperatures are much more complex. However, the formation of F_c^+ centres appears to be a necessary prerequisite to the formation of microscopic rectilinear voids which may be observed in transmission electron microscopy. (auth)

52484 RADIATION DAMAGE IN MAGNESIUM OXIDE. I. DOSE DEPENDENCE OF REACTOR DAMAGE. **Henderson, B.** (Univ. of Keele, Eng.); Bowen, D. H. J. Phys., C (London); 4: No. 12, 1487-95(Aug 1971).

The kinetics of saturation of F^+ centre production were studied in MgO after reactor irradiation. Although both vacancy and interstitial clusters are formed at high neutron dose, saturation does not result from clustering but is more probably caused by spontaneous recombination of vacancies and interstitials when these are separated by less than 18 nearest-neighbour distances. The production of interstitials and vacancies during irradiation results in growth of both the macroscopic and unit-cell dimensions of the crystals. Comparison of these changes suggests that below about 3×10^{19} nvt Frenkel defects are formed. At the lowest doses ($<3 \times 10^{17}$ nvt) the mean dilatation per Frenkel pair is estimated to be approximately 8 atomic volumes. At high doses (about 3×10^{19} nvt) Frenkel defects migrate to form interstitial clusters. Since this corresponds to the conversion of Frenkel defects to Schottky defects, the mean dilatation per interstitial decreases from approximately nine atomic volumes to one atomic volume. (auth)

52485 FUEL MICROSTRUCTURE VARIATIONS AS A CONSEQUENCE OF THE FIRST IRRADIATION PERIOD AND OF THE WAYS OF APPROACH-TO-POWER. Calza Bini, A.; Ferrante, E.; Nobili, A.; Rotoloni, P. L.; Testa, G. (CNEN, Rome). Energ. Nucl. (Milan); 18: No. 7-8, 408-18(Jul-Aug 1971).

An experimental investigation was performed on the microstructure variations of fuel material during the first hours of irradiation in reactors, as functions of time and of different methods of approach-to-power. A phenomenological model of fuel behavior during the first reactor start-up was derived from the obtained results. According to this model such behavior seems to influence the entire fuel life. (auth)

Plastics and Other Materials

Refer also to abstract 52386.

52486 (A/CONF.49/P-613) BEHAVIOR OF SPECIAL SHIELDING CONCRETES AND THEIR COMPONENTS UNDER NEUTRON IRRADIATION. Elleuch, M. F.; Dubois, F.; Rappeneau, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1971. 15p. (In French). (CONF-710901-253). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The effects of neutron irradiation on concretes, cements, and granulates were tested by irradiating specimens in the Triton reactor at increasingly high temperatures. After irradiation the changes in mass, dimensions, and thermal and mechanical properties (thermal conductivity, dynamic elastic modulus, breaking strength) of the samples are determined in a high-activity cell specially equipped for these studies. The irradiation devices used and the measurement methods are briefly described. Pure paste specimen of three different cements (aluminous Super Secar and Lafarge fused cement, metallurgical pozzolana cement) were irradiated at temperatures around 150°C and 10^{19} and 10^{20} n/cm^2 doses of energy >1 MeV. Specimens of serpentines and steatite were irradiated at temperatures of 200°C and 10^{19} and 10^{20} n/cm^2 doses of energy >1 MeV. Considerable dimensional variations and changes in the mechanical properties of these materials were observed. Following these experiments a concrete based on serpentine granulate and fused aluminous cement was irradiated at about 200°C and doses ranging from 10^{19} to 10^{20} n/cm^2 (energy >1 MeV); the components of this concrete were irradiated once more under the same conditions in order to establish the role of each in the behavior of the concrete. The interpretation of the results obtained shows that the part played by the granulate is preponderant where the dimensional changes of the concrete under irradiation are concerned, and that it also has a strong influence on the changes in the mechanical properties. (auth)

52487 (ORNL-tr-2515) THERMAL STRESS IN A HOLLOW CONCRETE CYLINDER. Fujiki, Y.; Nakamura, K.; Hisatomi, Y. Translated for Oak Ridge National Lab., Tenn., from Konkurito Janaru; 9: No. 6, 12-23(1971). 22p. Dep. NTIS.

With the increase in construction of nuclear power plants, knowledge on the properties of concrete under elevated temperature becomes more important. A model of reinforced concrete hollow cylinder (external diameter 2.4 m, internal diameter 1.6 m, and height 0.6 m) was heated internally and the temperature gradient and thermal stress measured by carbon-type strain gages and reinforced strain meters. The results of the thermal stress measurements of hollow concrete cylinder specimens are analyzed. (auth)

52488 (RHEL/R-220) EFFECT OF IONISING RADIATION ON SYNTHETIC RESINS AT VERY LOW TEMPERATURE. An Initial Study. Evans, D.; Morgan, J. T.; Stapleton, G. B. (Rutherford High Energy Lab., Chilton (England)). May 1971. 21p. Dep. NTIS (U. S. Sales Only). UK 30p.

Data are given of the effect of ionizing radiation on a number of plastics materials of potential value in the construction of superconducting magnets. The irradiation was performed in the main at liquid nitrogen temperature on flexural test specimens without replication. The results of flexural tests at room temperature were, however, seen to conform to the expected improvement in dose/degradation observed in other systems irradiated at low temperature. The effect of gas formation and consequent disruption of structure was also demonstrated. (auth)

52489 MELTING POT FOR IRREGULAR SHAPED LEAD SHOT-THERMOPLASTIC SHIELDS. Maruyama, Yosh (Univ. of Kentucky, Lexington); Burns, Dennis; Espy, Lawrence. Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 766-7(Aug 1971).

A simple melting pot for fabricating contoured shields of thermoplastic and lead shot for individualized shielding for use in the radiotherapy of the mantle field in Hodgkin's disease is described. (W.H.K.)

52490 TENTATIVE DESCRIPTIVE NOMENCLATURE OF CONSTITUENTS OF AGGREGATES FOR RADIATION-SHIELDING CONCRETE. ASTM C638-69T. Philadelphia; American Society for Testing and Materials (1969). 5p. Available from American Society for Testing and Materials, Philadelphia.

This nomenclature is intended to give accurate descriptions of some common or important naturally occurring and synthetic constituents of aggregates for radiation-shielding concrete, that, at the same time, are not common or important constituents of concrete aggregates in general use. While most of the minerals and rocks discussed below may occur in small quantities in aggregates in general use, they are not major constituents of such aggregates. Common constituents of aggregates in general use are described in ASTM Descriptive Nomenclature C 294, Constituents of Natural Mineral Aggregates. Radiation-shielding concrete often contains such aggregates, but other special aggregates are used in some circumstances. The synthetic aggregates included are ferrophosphorus and boron frits. The descriptions are not adequate to permit the identification of materials, since accurate identification of natural and synthetic aggregate constituents in many cases can only be made by a qualified geologist, mineralogist, or petrographer, using the apparatus and procedures of these sciences. (auth)

52491 TENTATIVE SPECIFICATION FOR AGGREGATES FOR RADIATION-SHIELDING CONCRETE. ASTM C637-69T. Philadelphia; American Society for Testing and Materials (1969).

4p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers special aggregates for use in radiation-shielding concretes in which composition or high specific gravity or both are of prime consideration. (auth)

52492 FURTHER DATA ON GAMMA-INDUCED ELECTRICAL CHARGE AND COLORATION OF SHIELDING GLASSES. Eckles, T. W.; Mingesz, D. P. (Argonne National Lab., Ill.). pp 143-7 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).

From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

Two cerium-protected shielding glasses, now available commercially, have been shown by irradiation testing to be immune to spontaneous electrical discharge during total exposures of at least 1×10^8 R at exposure rates as high as 1×10^6 R/hr. One, a lead glass of 3.27 specific gravity with greater than normal stabilization against gamma darkening, is Code 8459 produced by Corning. The second, a borosilicate glass of 2.53 specific gravity which also contains greater than normal stabilization against gamma darkening, is RS253G/25 by Schott Glass Inc. In addition, this second glass did not discharge electrically when given an impact shock immediately (within 20 min) after cessation of irradiation. Such glasses should be of interest to buyers of shielding windows where the first thick slab of glass is subjected to total exposures $>5 \times 10^6$ R at rates as low as 40,000 R/hr. These were the conditions under which the March 1970 incident of spontaneous discharge occurred in a shielding window installed in an active hot cell. (auth)

52493 QUALITY CONTROL OF CONCRETE USING A NEUTRON MOISTURE GAUGE. Kaga, Hideharu; Yamamoto, Moriyuki; Mizushina, Tomoyuki (Taisei Construction Co. Ltd., Tokyo). Taisei Kensetsu Gijutsu Kenkyusho-Ho; No. 3, 27-34 (Oct 1970). (In Japanese).

In case of mixing concrete in accordance with the standard mixing methods, variations in surface moisture held by fine aggregate is an important factor in quality control system for concrete. Variations in surface moisture in fine aggregate results in variations in the water-cement ratio and, therefore, the strength of concrete. Results of an automatic quality control study for standard concrete mixing by measuring surface moisture in sand for each batch are reported. To measure surface moisture content in sand, a neutron-moisture gage was set in the sand bin of concrete batching plant. The signals from the gage were fed back to the weigh beam to control the quality of concrete automatically. (auth) (Japan)

52494 SHIELDING MEANS FOR PROTECTION AGAINST NUCLEAR AND OTHER RADIATION. Menke, Josef-Ferdinand; Wesch, Ludwig. British Patent 1,225,111. 17 Mar 1971. Filed 30 Mar 1966.

The object of the shielding described is to provide protection to buildings, vehicles, etc. by the use of material of relatively low thickness (5 to 20 cm.) and light weight, such shielding being effective against neutrons and β-rays, against the heat of a nuclear explosion, and against aerial and gunfire attack. The shielding comprises plates of plastic material, reinforced with mineral fibers, and having suitable filler material. The plates may be contiguous or spaced apart in juxtaposition, and may be arranged to form a single, double, or multi-chamber system. The plates may be separated by mechanical damping layers. Filler materials include W, Th, Fe, Ba, rare earths, B, graphite, etc. SiO_2 and graphite fabric may be used as reinforcing material. Chambers formed between plates may be filled with a mixture of heavy and light water containing rare earths, graphite, BC, or emulsions of other inorganic substances. Lead or barium hydride may also be used. The reinforcing fibers may comprise glass containing Pb, Cd, Be, Al, rare earths, etc. (UK)

52495 HELIUM DIFFUSION IN LiH. Holt, J. B.; Almassy, M. Y.; Crawford, R. W. (Univ. of California, Livermore). J. Phys. Chem. Solids; 32: No. 9, 2129-33(Sep 1971).

Helium diffusion was studied in single crystals of LiH. The helium was introduced into the material by the nuclear reaction $^6Li(n,\alpha)^3H$. In the temperature range from 200 to 520°C, the apparent diffusion coefficient is given by: $D_A = 2.04 \exp(-28,200/RT)$. The results appear to be independent of radiation doses from 10^{15} to 10^{17} nvt, and of magnesium content up to 2300 ppm. The most plausible mechanism is the diffusion of helium atoms via interstitial sites as they are continually trapped at unspecified lattice defects. (auth) (UK)

PHYSICS (GENERAL)

Astrophysics and Cosmology

52496 REPORTS ON ASTRONOMY. **Transactions of the International Astronomical Union. Volume XIVA. de Jager, Cornelis (ed.). Dordrecht, Netherlands; D. Reidel Publishing Company (1970). 572p. f 65.-.**

These Reports on Astronomy contain essentially the tri-annual progress reports of the presidents of the 38 commissions of the IAU. These reports therefore represent a complete overall review of the whole field of astronomy. (W.D.M.)

Cosmic Ray Exposure Ages

52497 SOLAR PROTON MEDIUM FLUX CONSTANCY OVER A MILLION YEARS. **Lavrukhina, A. K.; Ustinova, G. K. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Nature (London); 232: No. 5311, 462-3(13 Aug 1971).**

Shedlovsky and others (Science 167: 574 (1970)) described how the activities of some radionuclides have been measured as a function of depth in a lunar sample; analysis of their data has enabled conclusions to be drawn regarding the possible constancy of solar proton flux over the last million or so years. Calculations are made of the depth distribution of primary cosmic-ray and secondary nuclear-active particles, as well as the distribution of cosmogenic radionuclides, for a large body with composition similar to that of lunar crystalline rock. Data are given for ^{22}Na, ^{55}Fe, and ^{26}Al. From the analysis presented it is concluded that, at least within ~30% error, the mean intensity of solar cosmic rays of energy >20 MeV has been constant over the last million years at about $31.1^{+5.6}_{-9.4}$ protons/cm^2/sec. This was confirmed by calculations of the radioactivities of ^{53}Mn and ^{54}Mn. (UK)

Stars

Refer also to abstracts 52894 and 53353.

52498 (UCRL—51055) STATISTICAL MECHANICS OF TWO-SPECIES PLASMAS, WITH APPLICATIONS TO WHITE DWARF STARS AND METALLIC HYDROGEN. **Buckholtz, Thomas J. (California Univ., Livermore. Lawrence Radiation Lab.). May 1971. Contract W-7405-eng-48. 105p. Dep. NTIS.** Thesis.

A method of determining the equation of state for certain dense plasmas for which the usual cluster expansions of statistical mechanics fail to converge is derived. The results are applied to physical conditions such as might be found in a white dwarf star from the envelope to deep in the interior. The work pertains to a two-species plasma of weakly coupled electrons and strongly coupled classical ions. Because of the strong ion coupling, the usual cluster expansions for the free energy fail to converge. By summing classes of diagrams, new expansions are obtained in which the ion—ion interactions are removed in favor of the ion density functions of various orders. The results include three categories of terms: one ion-only term (which is calculable by Monte Carlo means such as those of Brush, Sahlin, and Teller), the electron-only terms of the usual expansions, and some mixed-species diagrams. Expansions are given for three cases: classical particles and weak forces, classical electrons and Coulomb forces, and quantum electrons and Coulomb forces. In the second case a nodal expansion is found. The results for quantum electrons and classical ions are applied to fully ionized systems having intermediate or strong-ion coupling. Thereby, thermodynamic properties of white dwarfs from the envelope to the interior are explored. For the intermediate-coupling regime, a mixed-species diagram gives a more important contribution to the free energy than does any electron-only interaction term. At larger coupling this diagram continues to dominate the electron ring, but is smaller than electron exchange. The work is connected with previous work in two limits. In the limit of weak ion coupling there is agreement with results from the usual cluster expansions. For the high-density limit of a perfect crystal of nuclei an expression of Bellemans and De Leener is recovered for the polarization of the electron gas by the lattice. (auth)

52499 MAGNETIC FIELDS IN ROTATING STARS. **Haemeen-Anttila, K. A.; Ryynaenen, L. (Univ. of Oulu, Finland). Commentat. Phys.-Math.; 40: 175-90(1970).**

An exact special-relativistic treatment of the magnetic field inside a perfectly conducting rotating star is given. In the first approximation the results confirm Deutsch's similar work but predict a nonzero charge density. (auth) (Finland)

52500 EVIDENCE FOR BLACK HOLES IN BINARY STAR SYSTEMS. **Gibbons, G. W.; Hawking, S. W. (Cambridge Univ., Eng.). Nature (London); 232: No. 5311, 465-6(13 Aug 1971).**

It is stated that the general theory of relativity predicts that a star of more than about $1.4_{\odot}$ may undergo gravitational collapse to produce a black hole when its nuclear fuel is exhausted, and it would be an important confirmation of this theory if such holes could be detected. Their very small size makes it virtually impossible to observe them directly, but their existence could be inferred from the motion of other objects in their gravitational field. The natural place to look for them is in binary star systems in which only one object is observed (single-line binaries). Evidence is presented from a study of the eccentricities of the shortest-period binaries that some of these may contain black holes. (UK)

52501 ROTATING MAGNETIC WHITE-DWARF STARS AS X-RAY SOURCES. **Apparao, K. M. V. (Tata Inst. of Fundamental Research, Bombay). Nature (London) Phys. Sci.; 232: No. 33, 153-4(16 Aug 1971).**

It is shown that rotating magnetic white dwarfs can be x-ray emitters with a thermal spectrum; these stars emit low-frequency radiation that is absorbed by the surrounding gas, thus raising its temperature, with emission of x radiation. The case of Sco X-1, which emits x radiation with intensity 10^{36} to 10^{38} erg/sec, is considered in detail. No periodicity will be seen in the optical or x-ray emission, since the emission by the hot gas is a time average of the periodic input energy from the star. (UK)

52502 STELLAR COMPOSITIONS FROM NARROW-BAND PHOTOMETRY. I. IRON ABUNDANCES IN 180 G AND K GIANTS. **Williams, P. M. (Cambridge Observatories, Eng.). Mon. Notic. Roy. Astron. Soc.; 153: No. 2, 171-93(1971).**

Using narrow-band indices observed with the Cambridge spectrophotometer, red–infrared colours, and independent luminosity estimates, the iron abundances of 180 G and K type giant stars were determined. The indices were analysed using synthetic spectra computed from model atmospheres. The estimated uncertainties in [Fe/H] vary from 0.2 in metal-rich stars to 0.3 in metal-poor stars. A comparison with the results of detailed spectroscopic analyses by other authors yields a r.m.s. difference of only 0.13 in [Fe/H]. The abundances of a number of the possible members of the Hyades, Pleiades, Wolf 630, ζ Herculis, σ Puppis, 61 Cygni, η Cephei, and γ Leonis moving stellar groups are discussed. While most of the probable members of the Hyades group observed have iron abundances, [Fe/H] = 0.2, close to that of the cluster giants, most of the other groups are less homogeneous and contain more interlopers. The "old" group and high-velocity stars show a broad abundance distribution from metal-poor to super-metal-rich. (auth) (UK)

52503 RAPID DIFFERENTIAL ROTATION IN MAIN-SEQUENCE STARS. **Monaghan, J. J.; Smart, N. C. (Monash Univ., Clayton, Australia). Mon. Notic. Roy. Astron. Soc.; 153: No. 2, 195-204(1971).**

The structure of massive stars in rapid differential rotation is investigated using a perturbation method. Only the spherically symmetric terms are retained, but the equation of energy transport, with the neglect of circulation, is treated exactly. The results are in qualitative agreement with those obtained by Mark (1968) and show that rapid differential rotation can lead to a very large reduction in the luminosity of a star. The circulation time scale is estimated using Eddington's method (1929) as corrected by Öpik (1951). For those stars with the largest angular momentum the circulation time is comparable to the typical evolutionary time scale. (auth) (UK)

52504 ULTRAVIOLET CONTINUUM BRIGHTNESSES OF STARS MEASURED BY A ROCKET-BORNE PHOTOELECTRIC SPECTROPHOTOMETER. **Sudbury, G. C. (Royal Observatory, Edinburgh). Mon. Notic. Roy. Astron. Soc.; 153: No. 2, 241-9 (1971).**

Photoelectric spectrophotometric measures of 40 early-type stars in the range 1800 to 2800 Å and with 200 Å resolution were obtained by precessing scans of an objective dispersion monochromator. Normal, and three β Canis Majoris, stars show brightness well correlated with spectral type but three Ap stars have anomalous fluxes corresponding to late B-types. The interstellar extinction curves peak at 4.75 μ^{-1} with an observed f.w.h.m. of 0.45 μ^{-1}. The total interstellar flux density near 2400 Å and in the neighbourhood of the Sun is estimated at 3.5 × 10^{-17} erg cm^{-3} $Å^{-1}$, with only a small contribution from resolved stars. (auth) (UK)

52505 DO NEUTRON STARS HAVE AN OCEAN SURFACE. **Carter, B.; Quintana, H. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Nature (London); 232: No. 5310, 391-2 (6 Aug 1971).**

The possibility is discussed that there may be a vapour–liquid type phase transition, involving a major density discontinuity, between the crust of neutron stars and the underlying neutron superfluid. The discussion is largely centered on considerations of equations of state in many-fermion systems. It is thought probable that such a phase transition occurs, but much more elaborate techniques will be needed in order to decide conclusively whether or not neutron star matter has a large first-order phase discontinuity between subnuclear and nuclear densities. Such a discontinuity would in many ways be analogous to the terrestrial ocean surface, and might admit gravity waves, provided the mechanism by which they were generated, such as a starquake, could release sufficient energy to dissolve the crystal structure at the base of the crust. (UK)

52506 POSSIBLE EXISTENCE OF PARTICLES OF IMAGINARY MASS, ENERGY, AND MOMENTUM. **Fox, R. (Israel Inst. of Tech., Haifa). Nature (London) Phys. Sci.; 232: No. 32, 129-30(9 Aug 1971).**

A discussion is presented on the possible existence of particles known as "dybbuks" (Hebrew "roving spirit"). These particles would be time-like and no causality violation could occur. A possible description of the interactions of such particles is attempted. Amongst matters discussed are the gravitational constant and the weak-coupling constant. The findings are applied to evaluate the gravitational interaction of a very dense star, the probability of an upper limit to the mass of a cold white dwarf or neutron star, the collapse of neutron stars, and the possibility that present pulsar theories may be incorrect. (UK)

52507 HIGHLY REDDENED OBJECTS IN SAGITTARIUS. **Wray, James D. (Northwestern Univ., Evanston, Ill.). Astrophys. J.; 168: No. 3, L97-9(15 Sep 1971).**

Photographs taken in the near-infrared of IRC – 20385 with the 40-inch telescope at Northwestern University reveal the object to be a highly reddened globular cluster. Two other objects discovered in a search of the National Geographic Society–Palomar Observatory Sky Survey prints for morphologically similar objects in the Sagittarius area have also been observed. One of these objects is clearly a highly reddened cluster, probably globular. If so, at $l = 357.6°$, $b = +1.0°$ it becomes the closest known globular cluster to both the galactic nucleus and the galactic plane. The other object is apparently a cluster; and, although the observations are inconclusive, the morphological similarity of this object to the other two as seen on the Palomar Sky Survey prints, as well as arguments concerning the space density of stars in the cluster, suggests that it may possibly be a third globular cluster. (auth)

52508 RADIO EMISSION FROM ANTARES B. **Hjellming, R. M.; Wade, C. M. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 168: No. 3, L115-16 (15 Sep 1971).**

New interferometric data on the Antares radio source show that it is variable, detectable at both 3.7 and 11.1 cm, and associated with the B3 V companion to the red supergiant. (auth)

52509 DISCOVERY OF FLARE ACTIVITY ON YY GEMINORUM. **Moffett, T. J.; Bopp, B. W. (Univ. of Texas, Austin). Astrophys. J.; 168: No. 3, L117-20(15 Sep 1971).**

Flares were detected both spectroscopically and photometrically on the eclipsing, double-lined spectroscopic binary YY Gem. Simultaneous photometry and spectroscopy indicated that the relative intensity of flares observed in line versus continuum was markedly different in different flares. Previous spectroscopic observations may be explained by intermittent flare activity. (auth)

52510 ORIGIN OF MAGNETIC FIELDS IN WHITE DWARFS AND NEUTRON STARS. II. **O'Connel, R. F.; Roussel, K. M. (Louisiana State Univ., Baton Rouge). Lett. Nuovo Cim.; 2: No. 2, 55-7(10 Jul 1971).**

It is concluded that LOFER states are unlikely to exist in white dwarfs and neutron stars. If the LOFER states were associated with the ground-state energy of the system then one would expect large magnetic fields in all white dwarfs, which is contrary to observations. The fact that large magnetic fields are found in some white dwarfs might be due to the occurrence of some unusual circumstance resulting in the system going into a metastable LOFER state instead of the thermodynamically more stable $B = 0$ state. (W.D.M.)

52511 DIFFERENCE BETWEEN THE OOSTERHOFF TYPES I AND II GLOBULAR CLUSTERS. **Stobie, R. S. (Australian National Univ., Canberra). Astrophys. J.; 168: No. 3, 381-91 (15 Sep 1971).**

The period–frequency distribution of RR Lyrae variables in a globular cluster is interpreted in terms of pulsation theory. The globular clusters M3 and ω Cen are the most populous representatives of Oosterhoff Types I and II, respectively. By studying their period–frequency distributions in detail it is concluded that the variables in ω Cen are either more massive by $\Delta \log \mathfrak{M} = 0.10$ or more helium rich by $\Delta Y = 0.20$ than the variables in M3. Reasons are given for preferring the former alternative. It is shown that this difference is a general property of the Oosterhoff Types I and II. If this mass difference is correct, then it is concluded that differential mass loss must occur in the two types of clusters between the main sequence and the horizontal branch in the sense that the metal-rich clusters lose more mass than the metal-weak clusters. (auth)

52512 PHOTOMETRY OF M67 TO $M_v = +12$. **Racine, Rene. (Univ. of Toronto, Richmond Hill, Ont.). Astrophys. J.; 168: No. 3, 393-404(15 Sep 1971).**

New photographic photometry of M67 to the limit of the 200-inch telescope is reported. The reddening and ultraviolet excess of main-sequence stars are $E(B - V) = 0.09 \pm 0.02$ p.e., $\delta(U - B) = +0.035 \pm 0.007$ p.e. The $(V, B - V)$-diagram shows a thinly populated main sequence extending to the limit of the data at $V = 20.5$, $B - V = 1.7$. More than half of the M67 main-sequence stars between G2 and K5 appear to be unresolved multiple stars. A direct fitting to the Hyades main sequence yields $\Delta(m - M)_{AV} = 6.69 \pm 0.05$ p.e. (M67-Hyades). The observed population of faint blue objects to $V = 22$ is similar to the one observed in other high-latitude fields, and no white dwarfs appear to exist in M67 above $M_V = +12.2$. The relative evolutionary time scales, inferred from the observed density of stars along the M67 isochrone, is in general agreement with theoretical prediction, but the detailed shape of the isochrone disagrees with model calculations. (auth)

52513 SPECTROPHOTOMETRIC STUDIES OF GASEOUS NEBULAE. XIX. THE MODERATE-EXCITATION PLANETARY NGC 6826. **Czyzak, S. J. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware); Aller, L. H.; Kaler, J. B. Astrophys. J.; 168: No. 3, 405-11(15 Sep 1971).**

Photoelectric and photographic spectrophotometric observations of the relatively bright, moderate-excitation planetary NGC 6826 obtained at Lick, Mount Wilson, and Kitt Peak Observatories were combined to yield estimates of its density, temperature, and ionic concentrations. Data for ions of helium, carbon, nitrogen, oxygen, neon, sulfur, chlorine, and argon are presented. The nebula appears to be relatively homogeneous in the sense that dense low-excitation pockets with strong emissions of [N I], [N II], or [S II], prominent in many planetaries, play no important role here. In other words, the range of excitation seems to be relatively restricted. The surface brightness and spectroscopic data are consistent with a density of about 2300 electrons cm^{-3} and an electron temperature of 10000°K. (auth)

52514 PLANETARY NEBULAE. III. CHEMICAL ABUNDANCES. **Peimbert, Manual; Torres-Peimbert, Silvia (Univ., Mexico, Mexico City). Astrophys. J.; 168: No. 3, 413-21(15 Sep 1971).**

Chemical abundances of thirteen planetary nebulae were obtained from new photoelectric observations. The helium/hydrogen abundance ratio of planetary nebulae is very similar to that of H II regions. The average value derived from ten objects was $N(He)/N(H) = 0.110 \pm 0.015$; in this determination the effect of temperature fluctuations was taken into account. When the effect of collisional excitation in the intensities of λλ4472 and 5876 was considered, the value $N(He)/N(H) = 0.095 \pm 0.015$ was obtained. By comparing the intensity values of λλ4472 and 5876 it is suggested that the theoretical estimate of the collisional effect might be too large by a factor of 3. It was found that the nitrogen/oxygen abundance ratio was a factor of 3 to 5 times higher in planetary nebulae than in H II regions. This result is interpreted as due to the CNO bi-cycle in the nucleus of the parent star and subsequent convective mixing to the outer shells that later constitute the nebular envelope. (auth)

52515 DYNAMICS AND INFRARED RADIATION OF YOUNG, DUST-FILLED PLANETARY NEBULAE. **Kovach, William S. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware). Astrophys. J.; 168: No. 3, 423-36(15 Sep 1971).**

XUM

Five models of very young, dust-filled planetary nebula were constructed. The nebulae were idealized as spherical with a hot central star radiating as a blackbody. The H II region was completely enclosed by an H I region containing neutral hydrogen and dust grains. The ratio of the dust density to the gas density was assumed to be constant in the H I region. The neutral region was constructed so that the entire shell moves as a rigid body. The effect of Lα on the dynamics of the nebula was evaluated. The criteria for Jeans's gravitational instabilities were computed, and it was found that the nebula was stable against formation of condensations. The effects of sputtering by protons and evaporation were considered in evaluating the lifetime of grains as they enter the H II region. It was found that maximum lifetimes of only 100 years would be expected for individual grains once they are in the H II region. The amount of radiation absorbed and reradiated into the infrared by the grains in the H I region was evaluated. Account was taken of the Lα radiation, ultraviolet radiation from the central star, and self-absorption of infrared radiation in determining the temperature of the grains. The resulting infrared profile was computed and compared with the observations of NGC 7027. Good agreement between the models and the observations was obtained. The models predict a flux in the 150-μ region that is high when compared with the flux predicted for grains emitting at a uniform temperature throughout the H I region. (auth)

52516 EXISTENCE OF STABLE STARS IN THE CEPHEID INSTABILITY STRIP. **Fernie, J. D.; Hube, Joan O. (Univ. of Toronto, Richmond Hill, Ont.). Astrophys. J.; 168: No. 3, 437-42(15 Sep 1971).**

Forty-eight stars with spectral types near GO Ib were examined for light variability. Five stars, HD 191010, 239994, 84441, 213482, and 214847, were suspected of being variable by about 0.1 mag. The remaining forty-three stars appeared to be stable to within a few hundredths of a magnitude. HD 194012, with a published spectral type of F8 Ib, was found in fact to be an F7 V star. Intrinsic colors for many of the nonvariable stars were assembled from published BVRI photometry. Absolute magnitudes for a number of them were obtained from cluster membership, K-line widths, etc. Most of these stars appear to lie within the Cepheid instability strip on the H−R diagram; and in a few favorable cases for which the absolute magnitude seems well determined by several independent means, this conclusion appears almost certain. (auth)

52517 SPECTROSCOPIC STUDY OF ALGOL. **Hill, Graham; Barnes, J. V.; Hutchings, J. B.; Pearce, J. A. (Dominion Astrophysical Observatory, Victoria, B. C.). Astrophys. J.; 168: No. 3, 443-60(15 Sep 1971).**

The results of a radial-velocity study of Algol A, AB, and C are presented and revised elements for both the short-period (2.8673 . . . days) and long-period (1.862 years) orbits derived. A mass ratio $m_{AB}/m_C = 2.63 \pm 0.20$ is deduced. Reliable observational data on the orbit of Algol A are used to show that the line of apsides rotates with a period of 32 years. A new treatment of the rotation effect provides an explanation of the discrepancy between results based on broad and narrow lines, and a rotational velocity for Algol A of 55 ± 4 km s^{-1} has been derived. This and other considerations lead to a mass ratio m_A/m_B = 4.6. A complete physical model for the system is presented, and its evolutionary state is discussed. (auth)

52518 TEMPERATURE CONTROL BRACKET. **Gebbie, K. B.; Thomas, R. N. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). Astrophys. J.; 168: No. 3, 461-79(15 Sep 1971).**

The factors determining the temperature distribution in a stellar atmosphere are divided into transfer effects and population effects. As a measure of the latter, the Temperature Control Bracket [TCB] is introduced which, in radiative equilibrium, describes the control of T_e by the quantity and spectral distribution of the radiation field. Algebraic expressions for the [TCB] are given in terms of the microscopic rate processes for a pure hydrogen atmosphere. A caricatured computation is presented to demonstrate the influence of the various physical effects on the distribution of T_e in radiative equilibrium. (auth)

52519 OPTICAL APPEARANCE OF COLLISIONLESS GAS OF STARS SURROUNDING A BLACK HOLE. **Gerlach, Ulrich H. (Battelle Memorial Inst., Columbus, Ohio). Astrophys. J.; 168: No. 3, 481-93(15 Sep 1971).**

A thin-shelled ensemble of noncolliding luminous particles, such as stars, surrounding a collapsed configuration, a black hole, was considered and (a) the spectral flux density and (b) the brightness across the observed disk as seen by a distant observer were determined. (auth)

52520 EFFECT OF ELECTROMAGNETIC RADIATION ON THE SECULAR STABILITY OF A HOMOGENEOUS, CHARGED, ROTATING DROP. **Stettner, R. (Univ. of Chicago). J. Math. Phys. (N. Y.); 12: No. 7, 1159-62(Jul 1971).**

It is shown that electromagnetic radiation induces a secular instability in a homogeneous rotating charged drop, held together by surface tension, at the point of bifurcation at which a triaxial sequence of equilibrium figures branches from the axially symmetric figures. (auth)

52521 STRONG SHOCK WITH RADIATION NEAR THE SURFACE OF A STAR. **Sachdev, P. L.; Ashraf, S. (Indian Inst. of Science, Bangalore). Phys. Fluids; 14: No. 10, 2107-10(Oct 1971).**

The propagation of a shock wave, originating in a stellar interior, is considered when it approaches the surface of the star and assumes a self-similar character, "forgetting" its initial conditions. The flow behind the shock is assumed to be spatially isothermal rather than adiabatic to simulate the conditions of large radiative transfer near the stellar surface. The adiabatic and isothermal flows behind such a shock are compared. The exact shock-propagation laws, obtained by solving the equations in similarity variables, for different values of the parameter δ in the undisturbed density law, $\rho_0 \propto x^\delta$, and γ, the ratio of specific heats, are compared with the approximate values calculated by Whitham's characteristic rule and the two show a generally good agreement. (auth)

52522 SATELLITE BANDS OF THE γ'-SYSTEM OF TITANIUM OXIDE. **Phillips, John G. (Univ. of California, Berkeley). Astrophys. J.; 169: No. 1, 185-9(1 Oct 1971).**

The $\lambda\lambda$6148 and 6174 bands in the spectrum of TiO are shown to be satellite bands of the (0,0) band of the γ'-system. The corresponding transitions are B $^3\Pi_1$−X $^3\Delta_1$ and B $^3\Pi_2$−X $^3\Delta_2$. Their identification makes possible a direct observational determination of the triplet splittings in the four known triplet electronic states of TiO. (auth)

52523 USE OF LINEAR INTERPOLATION IN OPACITY TABLES. **Rood, Robert T. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 169: No. 1, 191-3(1 Oct 1971).**

Insofar as they influence the results of stellar-interior calculations, errors resulting from the use of linear interpolation in opacity tables are not negligible. They may be large enough to negate many of the recent improvements in opacity tables. (auth)

52524 SPECTROSCOPIC OBSERVATIONS OF VY CANIS MAJORIS DURING 1969–1971. **Wallerstein, George (Univ. of Washington, Seattle. Univ. of California, Berkeley). Astrophys. J.; 169: No. 1, 195-7(1 Oct 1971).**

New spectra of VY CMa show few changes except that Hα may be shifting to the violet, indicating the beginning of a period of renewed activity. New identifications include Rb I, TiO, and VO band heads. An ionization temperature between 900° and 1200°K is derived from the presence of sufficient neutral rubidium to produce the Rb I emission lines. From the presence of λ6572 of Ca I and the absence of λ6300 of [O I] the allowed range of N_H is from 10^7 to 5×10^{12} cm^{-3}. (auth)

52525 LINE INTENSITIES IN NGC 7027. **Kaler, J. B. (Univ. of Illinois, Urbana); Czyzak, S. J.; Aller, L. H. Astrophys. J.; 169: No. 1, 199-201(1 Oct 1971).**

New photographic observations of NGC 7027 confirm Miller's finding that earlier spectrophotometry of NGC 7027 is afflicted with strong systematic errors. (auth)

52526 CLOSER LOOK AT INTERSTELLAR LYMAN-ALPHA ABSORPTION. **Jenkins, Edward B. (Princeton Univ., Cambridge, Mass.). Astrophys. J.; 169: No. 1, 25-32(1 Oct 1971).**

Previous measurements of the equivalent widths of the interstellar Lα absorption in the spectra of hot stars observed on rocket flights in most cases have yielded considerably lower column densities of atomic hydrogen than those derived from low-resolution observations by the Wisconsin far-ultraviolet spectrometer aboard the OAO-A2 satellite. This disagreement has prompted a re-examination of some of the rocket data and the development of a maximum-likelihood analysis for the detailed fitting of theoretical absorption profiles to the observations. This reduction procedure virtually eliminates a fundamental uncertainty on where a continuum level should be placed, a problem which has been suggested as a significant source of error in earlier equivalent-width measurements. The rocket spectra of δ, ϵ, and ζ Ori and ζ Pup were chosen for the more detailed reanalysis, and column densities of 1.30 (+0.75, −0.55), 1.75(+0.80, − 0.35), 1.75(+0.70, −0.50), and 0.70(+0.18, −0.17) × 10^{20} atoms cm^{-2} were derived for the respective stars. Although these numbers are only slightly larger than the previous values, rocket measurements for other stars may have more significant errors which could be eliminated by the treatment discussed. The results for the four stars are still about a factor of 10 less than the OAO measurements. Hence the blending of strong stellar lines into the Lα profile observed by the OAO appears for these stars to be more severe than previously anticipated. (auth)

52527 RADIO EMISSION FROM STELLAR CORONAS. Oster, Ludwig (Univ. of Colorado, Boulder). Astrophys. J.; 169: No. 1, 57-61(1 Oct 1971).

Recent radio observations by Wade and Hjellming were used to derive a plausible base density for a hot (10^6°K) corona of M supergiants. It is argued that the observed radio emission might correspond to the equivalent of solar Type IV microwave bursts, and it is pointed out that this interpretation could be checked with relatively little observational labor. (auth)

52528 LIGHT CURVES OF MIRA VARIABLES AT 1.04 MICRONS. Lockwood, G. W. (Kitt Peak National Observatory, Tucson, Ariz.); Wing, Robert F. Astrophys. J.; 169: No. 1, 63-86(1 Oct 1971).

Near-infrared light curves were compiled for twenty-five Mira variables of types M and S from photoelectric measurements of the radiation contained in a narrow bandpass near 1.04 μ. An average of twenty-seven observations per star was collected over a 5-year interval. The I(104) magnitudes are almost completely free from molecular blanketing; the amplitudes at this wavelength are typically only 1.0 mag and never exceed 2.5 mag. Observations at the same phase in different cycles usually agree to within 0.1 mag, but differences as large as 0.5 mag have been recorded. Maximum light in I(104) occurs approximately 0.1 period after visual maximum. Light curves at different infrared wavelengths with varying degrees of blanketing all have the same general character as the visual light curve of each star, although the amplitude depends upon the amount of blanketing. Spectral types were derived from measurements of TiO and VO bands made simultaneously with the measurements of I(104). 595 spectral types are given for the twenty-two M and mild S stars and a judgment as to each star's most representative type at minimum light. Pronounced humps on the rising branch, near phase 0.7, were observed in many stars; several stars have shown humps in some cycles but not in others. They cannot be attributed to changes in blanketing, since they are as evident in I(104) as at other wavelengths and since the spectral type actually stays constant at its latest value during the rapid rise from minimum to secondary maximum. The rise from minimum seems to be associated with an increase in photospheric temperature, while the delay in the resulting dissociation of TiO and VO emphasizes the extreme stratification of these atmospheres. (auth)

52529 IONIZATION AND HEATING OF THE GUM NEBULA BY ENERGETIC PARTICLES FROM THE VELA X SUPERNOVA. Ramaty, R. (Goddard Space Flight Center, Greenbelt, Md.); Boldt, E. A.; Colgate, S. A.; Silk, J. Astrophys. J.; 169: No. 1, 87-96(1 Oct 1971).

A model was investigated in which the Gum Nebula is ionized and heated by energetic particles from the supernova associated with the Vela X remnant. It was found that the observed ionization could be produced in from 10^4 to 2×10^4 years by the ejection of about 1 to 2 $M_\odot$ of the products of silicon burning at a mean energy of a few MeV per nucleon. The consequences of this model were investigated for the ionization and heating of the interstellar medium, the generation of the light elements, x-ray production, and observable cosmic rays. (auth)

52530 BOOTSTRAP EQUATION OF STATE FOR COLD ULTRADENSE MATTER. Wheeler, J. Craig (California Inst. of Tech., Pasadena). Astrophys. J.; 169: No. 1, 105-11(1 Oct 1971).

An equation of state for zero-temperature ultradense (≫ nuclear density) matter is derived, based on the "bootstrap" concept of the hadron mass spectrum. The result for a particular choice of parameters is $P = \epsilon c^2/\ln(\epsilon/\epsilon_0)$, where ϵ is the total mass-energy density and $\epsilon_0 = 2.5 \times 10^{12}$ g cm^{-3}. (auth)

52531 ANALYTIC APPROACH TO THE EVOLUTION OF DEGENERATE CARBON CORES OF STARS. Arnett, W. David (Rice Univ., Houston, Tex.). Astrophys. J.; 169: No. 1, 113-18 (1 Oct 1971).

An analytic procedure for calculation of the evolution of degenerate massive stellar cores is described and compared with detailed numerical results. This procedure provides a simple computational method for investigating such objects as well as a simple physical picture for understanding them. (auth)

52532 STABILITY OF SUPERMASSIVE DISKS AGAINST FRAGMENTATION. Quirk, William J.; McKee, Christopher F. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Astrophys. J.; 169: No. 1, 119-24(1 Oct 1971).

Applying Newtonian stability criteria for both uniform and differential rotation, it was found that rotating, relativistic, supermassive (mass $>10^5$ $M_\odot$) disks with a height W greater than one-twentieth of the radius R are stable against fragmentation. The disk must be in a state of strong differential rotation to be stable against assuming an ellipsoidal configuration. The results were consistent with the hypothesis that these disks can be thin enough to release at least a few percent of Mc^2 and still be stable against fragmentation. (auth)

52533 SOME SPECTROSCOPIC CHARACTERISTICS OF THE OB STARS: AN INVESTIGATION OF THE SPACE DISTRIBUTION OF CERTAIN OB STARS AND THE REFERENCE FRAME OF THE CLASSIFICATION. Walborn, Nolan R. (Univ. of Chicago). Astrophys. J., Suppl. Ser.; 23: No. 198, 257-82 (Aug 1971).

The distances of stars from the Victoria list of revised Hγ spectrophotometric absolute magnitudes were reinvestigated by means of MK spectral classification at 63 Å mm^{-1}. The two systems were compared with respect to spectral types, absolute magnitudes, and space distribution of the individual stars; marked systematic and accidental differences were found to exist for the O9–B2 stars. The Victoria spectral types were systematically later, and the revised Victoria magnitudes consistently fainter, than those derived. In terms of the present classifications, it was found that the OB stars investigated delineate the Local and Perseus spiral arms. Because the work was done with a dispersion approximately twice that of the MK atlas, the spectral classification was investigated in detail. With a reference frame based upon ratios of the lines of helium and silicon, an increased classification resolution in the range O9–B1 was obtained. A luminosity classification for the earlier O stars is proposed. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 52501 and 52718.

52534 LINE SHIFTS IN THE SPECTRUM OF THE QUASI-STELLAR OBJECT PKS 0237-23. Aurela, A. M.; Noteva, V. (Univ. of Turku, Finland). Ann. Acad. Sci. Fenn., Ser. A VI; No. 348, 1-8(1970).

The absorption spectrum of PKS 0237-23 was reconsidered with the purpose of reducing the total number of necessary redshift systems by introducing a new hypothetical line-shift mechanism. According to the hypothesis, very large level shifts of the type of Lamb shifts were allowed for in low s-levels. Such a hypothesis was based on a qualitative model of the "electromagnetic" effects of a universal neutrino sea and semiquantitative indications of strong enhancement of Lamb shifts in the Sun. The laboratory lines employed were the same or similar as before. Acceptable identifications were found for 72 lines (of the 92 lines observed) by the use of the redshifts 2.1830 and 1.9385 and the enhanced Lamb shifts. A computer search for other kinds of systematic shifts was carried out, but no other systematism was found. Taking into account the remaining uncertainties, the only conclusion that could be drawn was that the occurrence of enhanced Lamb shifts in PKS 0237-23 is possible. (auth) (Finland)

52535 FLUX DENSITIES AND POSITIONS OF SOUTHERN GALACTIC SOURCES AT 1410 MHz. Manchester, B. A. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Aust. J. Phys., Astrophys. Suppl.; No. 12, 1-9(Nov 1969).

Flux densities and positions were determined for sources in the 1410-MHz survey of the Southern Milky Way, carried out with the Parkes 210-ft radio telescope. (Australia)

52536 COHERENT NEUTRAL SHEET RADIATION FROM PULSARS. Michel, F. C. (Rice Univ., Houston, Tex.). Comments Astrophys. Space Phys.; 3: No. 3, 80-6(May-Jun 1971).

It has become clear that the rf pulses from pulsars must be ascribed to coherent radiation mechanisms; otherwise, kinetic thermal temperatures in excess of 10^{25} °K would be implied by the observational data. Two apparently divergent proposals have been made, namely, that the radiation mechanism follows from (1) maser behavior, or (2) particle bunching. The first suggestion calls for anisotropy in velocity space while the second calls for anisotropy in configuration space. Nature generally supplies both anisotropies and, in fact, one usually produces the other. A pulsar model is described in which the rf radiation could be attributed to either mechanism. (W.D.M.)

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52537 MECHANISM OF THE GLITCHES IN THE CRAB NEBULA PULSAR. Scargle, Jeffrey D. (Univ. of California, Santa Cruz); Pacini, Franco. Nature (London) Phys. Sci.; 232: No. 33, 144-9(16 Aug 1971).

New observations of the wisps in the Crab Nebula show further examples of activity connected with sudden changes in the rotation rate of the pulsar. The evidence leads to a model of the "glitches" in which plasma is released explosively from the closed magnetosphere of the neutron star. (auth) (UK)

52538 PRECISE POSITIONS OF TWENTY-EIGHT RADIO SOURCES. Smith, J. N. (Cavendish Lab., Cambridge, Eng.). Nature (Lodnon) Phys. Sci.; 232: No. 33, 150-2(16 Aug 1971).

Data are presented that were obtained using the modified Cambridge 1-mile telescope, giving an accuracy believed to be to 0.2" arc at frequencies of 2.7 and 5 GHz. Details are given of the equipment and technique employed, and positions are tabulated. Also shown, in graphical form, are the radio positions plotted relative to the optical positions. Both wintertime and summertime (1970) observations were made. More consistent optical positions will be required before conclusions can be drawn concerning the physical relationship between the optical and radio sources. (UK)

52539 OBSERVATIONS OF THE DISTRIBUTION OF POLARIZED EMISSION OF CYGNUS A AT 6-CM WAVELENGTH. Mitton, Simon (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 153: No. 2, 133-43(1971).

High-resolution observations, at a wavelength of 6 cm, of the distribution of polarized emission from Cygnus A are presented. It was found that there are significant variations of the magnitude and position angle of the polarization across each source component. Although there are no observations at other wavelengths with sufficient resolution to show this structure, a comparison of the integrated polarization from each component over the range 1.55 cm < λ < 6 cm confirms the earlier conclusion that the rotation measure of the east component is much greater than that of the west component. The observations are related to a number of specific source models but none of them provide an entirely satisfactory explanation for the distribution of polarized emission. (auth) (UK)

52540 CIRCULAR POLARIZATION OF QUASARS. Pacholczyk, A. G.; Swihart, T. L. (Univ. of Arizona, Tucson). Mon. Notic. Roy. Astron. Soc.; 153: No. 2, 3P-5P(1971).

A synchrotron optical depth effect, which might be responsible for the observed sign reversal of the circular polarization in certain compact radio sources, is suggested and briefly discussed. (auth) (UK)

52541 FRICTIONAL HEATING IN NEUTRON STARS. Greenstein, George (Princeton Univ., N. J.). Nature (London) Phys. Sci.; 232: No. 32, 117-19(9 Aug 1971).

If neutron star interiors are superfluid, heat is dissipated within the star as its rotation is slowed. This process sets a lower limit to the temperature such a star can attain; the limit is such that thermal x-ray emission from certain pulsars may be detectable. (auth) (UK)

52542 OBSERVATION OF THE CRAB NEBULA AT 30 TO 100 keV. Smathers, H. W.; Chubb, T. A. (Naval Research Lab., Washington, D. C.); Sadeh, D. Nature (London) Phys. Sci.; 232: No. 32, 120-1(9 Aug 1971).

Measurements are described of the pulsed emission of hard x rays from the pulsar NP 0532, made with a balloon-borne x-ray telescope launched from Palestine, Texas, on Oct 17, 1970. The detectors comprised three Xe-filled proportional counters sensitive in the 30- to 100-keV x-ray region. Charged-particle rejection was achieved by surrounding the detector with an anticoincidence shield of Ar-filled proportional counters. Details are given of the experimental equipment employed and of the data recording system. Results are compared with those of other workers. (UK)

52543 OPTICAL IDENTIFICATION OF CYGNUS X-1. Kristian, J. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Brucato, R.; Visvanathan, N.; Lanning, H.; Sandage, A. Astrophys. J.; 168: No. 3, L91-3(15 Sep 1971).

It is believed that the bright star at the location of the radio source near Cyg X-1 may not be associated with the x-ray source because its distance is greater than the upper limit for the distance to Cyg X-1, and because its spectrum and energy distribution are those of a normal B0 supergiant, with no peculiarities seen. Analysis of presently incomplete data suggests possible peculiarity of a very red faint star, which is the only other object in the radio error box brighter than V ~ 19. Available data indicate that Cyg X-1, whether or not it is the radio source, must be intrinsically several magnitudes fainter than, or have much redder colors than, either Sco X-1 or Cyg X-2. (auth)

52544 SEARCH FOR AN OPTICAL SOURCE AT THE POSITION OF CENTAURUS XR-3. Elliot, J. L. (Harvard Univ., Cambridge, Mass.); Horowitz, P.; Liller, W.; Papaliolios, C.; Veverka, J. Astrophys. J.; 168: No. 3, L95-6(15 Sep 1971).

On plates reaching to the sixteenth magnitude (photographic), no pulsating optical source identifiable with the pulsating x-ray source Cen XR-3 was found within 3 standard deviations of the position given by Giacconi et al. No unusually blue stars exist down to nineteenth B-magnitude in the same area of the sky. (auth)

52545 DETECTION OF METHYL ALCOHOL IN ORION AT A WAVELENGTH OF ~1 CENTIMETER. Barrett, A. H.; Schwartz, P. R.; Waters, J. W. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 168: No. 3, L101-6(15 Sep 1971).

Five transitions of CH_3OH, corresponding to the $J = 4, 5, 6, 7$, and 8 rotational levels, at frequencies of approximately 25 GHz, were detected in Orion A. The source of emission is less than 1 arc minute in angular size and appears to be coincident with the infrared nebula. Although departures from LTE are evident in the line intensities, if the emission originates in the infrared nebula then a temperature of ~90°K, a column density of $\sim 5 \times 10^{16}$ CH_3OH molecules per cm^2, and a CH_3OH density of 0.25 molecules per cm^3 are indicated. Collisional excitation requires a total gas density of $\sim 2 \times 10^6$ cm^{-3} and a total mass of gas in excess of 20 $M_\odot$. (auth)

52546 DETECTION OF MILLIMETER EMISSION LINES FROM INTERSTELLAR METHYL CYANIDE. Solomon, P. M. (Columbia Univ., New York. Univ of California, San Diego); Jefferts, K. B.; Penzias, A. A.; Wilson, R. W. Astrophys. J.; 168: No. 3, L107-10(15 Sep 1971).

The 2.7-mm $J = 6 \rightarrow 5$ transition of methyl cyanide was detected in the Sgr B and Sgr A molecular clouds. The presence of several lines from excited K levels indicates a kinetic temperature ~150°K. The hydrogen density derived from excitation rates is $n_{H_2} \sim 10^6$ cm^{-3}. (auth)

52547 DETECTION OF INTERSTELLAR CARBONYL SULFIDE. Jefferts, K. B. (Bell Telephone Labs., Murray Hill, N. J.); Penzias, A. A.; Wilson, R. W.; Solomon, P. M. Astrophys. J.; 168: No. 3, L111-13(15 Sep 1971).

The 109.5-GHz, $J = 9 \rightarrow 8$ transition of carbonyl sulfide (OCS) was detected in the Sgr B molecular cloud. The column density is $N \geqq 3 \times 10^{15}$ cm^{-2}, which is comparable to formaldehyde, cyanoacetylene, and ammonia. (auth)

52548 LIMITING ^{3}He ABUNDANCES IN FOUR H II REGIONS. Predmore, C. R.; Goldwire, H. C. Jr., Walters, G. K. (Rice Univ., Houston, Tex.). Astrophys. J.; 168: No. 3, L125-9(15 Sep 1971).

A search for the 3.46-cm hyperfine line of singly ionized ^{3}He in galactic H II regions has given for M17 a 4 σ upper limit of $^3He/H = 5.3 \times 10^{-5}$. Similar limits were obtained for W3, the Orion Nebula, and W51. These values place limits on the amounts of ^{3}He which could have been produced by stellar nucleosynthesis and are consistent with a gradual ^{3}He enrichment of the interstellar medium over a time of several billion years. In conjunction with this measurement, the H171,7 line was detected in the four H II regions observed. (auth)

52549 EFFECT OF RECOIL IN RESONANCE-LINE SCATTERING. Adams, Thomas F. (Univ. of Arizona, Tucson). Astrophys. J.; 168: No. 3, 575-7(15 Sep 1971).

A discussion of recoil from a microscopic point of view and direct numerical calculations show that recoil can be neglected for resonance-line scattering that involves Doppler redistribution. Further arguments show that recoil can be neglected in problems of physical interest even when the damping wings are important. (auth)

52550 ACCELERATION AND RADIATION AROUND OBLIQUE ROTATORS. Cavaliere, A. (American Science and Engineering, Cambridge, Mass.). Nuovo Cim.; 5B: No. 1, 110-18(11 Sep 1971).

Particles accelerated by the em fields existing near a rotating, magnetized neutron star are widely held to be the source of activity of NP 0531, and of the whole Crab Nebula at high frequencies at least. The main features of the radiation from these particles are derived and a) the production of flashes in ir to x-ray bands in the upper magnetosphere, a feature likely associated with any appreciable azimuthal asymmetry of the stellar magnetic field, b) the sweeping of high-energy electrons beyond $r \approx c/\Omega$, and c) the nebular radiation as resulting from the wave field configuration extending unperturbed into the Nebula, the least realistic feature of the model, are discussed. (auth)

52551 RADIO STARS. Hjellming, R. M.; Wade, C. M. (National Radio Astronomy Observatory, Green Bank, W. Va.). Science; 173: No. 4002, 1087-92(17 Sep 1971).

Within the past 10 years radio emissions have been detected from six distinct classes of stars: red-dwarf flare stars, red supergiants, a blue dwarf companion to a red supergiant, novas, pulsars, and x-ray stars. After a brief review of solar radio emission, the known and the unknown concerning radio stars are discussed. An attempt is made to assess some of the prospects for this new area of radio astronomy. (W.D.M.)

52552 PROPERTIES OF PULSARS. Huguenin, G. R. (Univ. of Massachusetts, Amherst); Manchester, R. N.; Taylor, J. H. Astrophys. J.; 169: No. 1, 97-104(1 Oct 1971).

The correlation of various observed properties of pulsars is discussed with reference to the subdivision of pulsars into three groups on the basis of their mean pulse profile and subpulse phase modulation. Type S pulsars have simple pulse profiles, Type C pulsars have complex pulse shapes with more than one intense component, and Type D pulsars are characterized by drifting-subpulse behavior. It is shown that Type D pulsars are weakly polarized, in contrast to Type C pulsars which generally have a high degree of linear polarization. Type S pulsars have short periods, but may have large or small percentage polarization. For Types C and D the fractional pulse width is large, but for Type S pulsars it appears to be inversely related to the maximum rate of change of position angle through the pulse. The quantity $PP_{,t}$, which is thought to be proportional to the square of the magnetic-dipole moment, is shown to cover a wide range, with Type C pulsars having large values and Type D pulsars small values. The apparent lack of dependence of $PP_{,t}$ on period implies that the dipole moment is not a function of the pulsar age. The correlations observed suggest that young and short-period pulsars are generally Type S. Then as their period increases, those pulsars with large values of $PP_{,t}$ evolve to become Type C pulsars, whereas those with small $PP_{,t}$ values become Type D. (auth)

52553 HIGH-RESOLUTION OBSERVATIONS OF COMPACT RADIO SOURCES AT 6 AND 18 CENTIMETERS. Kellermann, K. I. (National Radio Astronomy Observatory, Green Bank, W. Va. California Inst. of Tech., Pasadena); Jauncey, D. L.; Cohen, M. H.; (and others). Astrophys. J.; 169: No. 1, 1-24 (1 Oct 1971).

The small-scale structure of extragalactic radio sources was studied at 18- and 6-cm wavelengths by using a tape-recording interferometer. At the longest antenna spacing, 10536 km, the baseline at 6 cm was 176 million wavelengths and the resolution was about 0.0004" for the stronger sources. Many sources, including optically identified galaxies and QSOs, were found to have several distinct components of widely differing size in the range from a few hundredths of a second of arc to the limit of the resolution. In general, the smallest components were strongest at the shortest wavelengths, and the dimensions were in good agreement with those expected if the low-frequency cutoffs are due to synchrotron self-absorption. The magnetic field strengths deduced from the observations and the self-absorption cutoff frequency were typically of the order of 10^{-4} gauss. The maximum brightness temperatures observed were 10^{11} to 10^{12}°K. Many sources, including 0106 + 01, 3C 273, 3C 279, 1555 + 00, 2145 + 06, 3C 446, 3C 454.3, and 2345 – 16 all contained components which were unresolved on the longest baseline and were less than 0.0004" in diameter. Observations at shorter wavelengths will be required to resolve these sources. Because the maximum brightness temperature is limited to 10^{12}°K by inverse Compton scattering, baselines no greater than the diameter of the Earth are probably adequate to resolve all of the stronger extragalactic sources. One source, 3C 84, has shown an apparent increase in angular size of about 35% in one year. (auth)

52554 RAPIDLY CHANGING RADIO IMAGES. Cavaliere, A. (American Science and Engineering, Cambridge, Mass.); Morrison, P.; Sartori, L. Science; 173: No. 3996, 525-8 (6 Aug 1971).

Differences in total transit time can give rise to images that expand at arbitrarily high speed. Two versions of a model based on this idea can account for the varying microwave structure reported for the quasar 3C 279. Other possible examples are suggested. (auth)

Solar Phenomena

52555 (LA-DC-12515) AVERAGE THERMAL CHARACTERISTICS OF SOLAR WIND ELECTRONS. Montgomery, Michael D. (Los Alamos Scientific Lab., N. Mex.). [1971]. 14p. (CONF-710328-1). Dep. NTIS.

From Solar wind conference; Pacific Grove, Calif. (22 Mar 1971).

Some average solar-wind electron properties based on an extended and significant Vela 4 data sample are presented. The sample used covered the period from May 1967 to May 1968. The thermal properties of the electron component of the plasma are primarily considered. In particular, the electron-to-ion temperature ratio, the electron thermal anisotropy, the total pressure anisotropy, and thermal conduction properties are discussed. (W.D.M.)

52556 THEORY OF QUIESCENT PROMINENCES. Pikel'ner, S. B. (Sternberg Astronomical Inst., Moscow). Comments Astrophys. Space Phys.; 3: No. 3, 73-9(May-Jun 1971).

The theory of quiescent prominences involves two main questions: the equilibrium and stability of magnetohydrodynamical systems and the mechanism of their origination. Both questions are considered, with emphasis on the second. (W.D.M.)

52557 LINE SHIFTS IN THE SOLAR SPECTRUM. Aurela, A. M. (Univ. of Turku, Finland). Ann. Acad. Sci. Fenn., Ser. A VI; No. 347, 1-15(1970).

The solar lines of H, He, and Li exhibit redshifts which could not be completely explained in terms of gravitational redshifts, collisional shifts, and Doppler shifts. The visible and ultraviolet lines could be accounted for semiquantitatively by accepting a hypothesis according to which the Lamb shifts would be about four times larger in the normal regions of the Sun than on the Earth, and in the solar activity regions even larger. The observations on the solar infrared lines are less precise, and most of them did not warrant a useful analysis. Support was found for the identifications of the disputed solar Li lines and of the line He II 4–5$\lambda_{\odot}$ 10123.895 Å. (auth) (Finland)

52558 SOLAR ELECTRON TEMPERATURES AND X-RAY FLARE ACTIVITY. Horan, D. M.; Kreplin, R. W. (Naval Research Lab., Washington, D. C.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 8, 1634-6(Aug 1971).

Changes in the magnitude or spectral character of the solar x-ray flux must be associated with changes in the solar source regions. It has been shown that the electron density, volume, and electron temperature associated with the source region are parameters that will affect these changes. It is possible to use a pair of broad-band x-ray sensors to measure changes in these parameters. A brief outline of the technique is given along with an application to OGO-4 and OSO-5 data. (W.D.M.)

52559 COMMENTS ON NEUTRONS AS AN ENERGY SOURCE FOR THE SOLAR CORONA. Chupp, E. L. (Univ. of New Hampshire, Durham). Nature (London) Phys. Sci.; 232: No. 33, 152(16 Aug 1971).

Reference is made to Fowler and Hashemi (Nature, 230: 518(1971)) who suggested a coronal heating mechanism depending on the decay of neutrons produced in the photosphere, with energy loss of the charged decay fragments. It is pointed out that the existence of a photospheric neutron flux of the magnitude suggested would be detectable through observation of a flux of 2.22-MeV neutron–proton capture γ rays emanating from the outer photosphere, and it is shown that the capture γ flux expected from this mechanism would be several orders of magnitude larger than observations of the continuous and sporadic emission of the 2.22-MeV γ ray line from the Sun would indicate. It is concluded that, although neutrons are produced copiously in nuclear reactions near the solar surface when sufficiently energetic particles are present, it is doubtful whether they play a significant part in the energy input into the chromosphere and the corona. (UK)

52560 ALFVENIC WAVE PRESSURES AND THE SOLAR WIND. Belcher, J. W. (California Inst. of Tech., Pasadena). Astrophys. J.; 168: No. 3, 509-24(15 Sep 1971).

Using a one-fluid polytrope model of the solar wind, the detailed behavior of outwardly propagating coronal Alfvén waves and their effects on the dynamics of the expanding solar corona as they propagate and are convected into interplanetary space were investigated. The waves exert an effective pressure on the solar wind, analogous to a radiation pressure, and inclusion of the energy fluxes of Alfvénic waves can result in significant changes in the large-scale streaming properties of the solar wind.

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Under some conditions, the coronal Alfvén waves can provide the primary energy flux needed to drive the wind. The relevance of this model to observed streaming properties of the solar wind is discussed. An attractive feature of the wave-driven solution is the ability of the waves to produce a combination of high velocities ($\simeq$700 km s^{-1}) and low densities ($\simeq$2 particles cm^{-3}) at 1 A. U. for reasonable coronal conditions at 10^6 km. (auth)

52561 OBSERVATIONS OF THE SOLAR OSCILLATORY COMPONENT AT A WAVELENGTH OF 3 MILLIMETERS. Simon, M. (State Univ. of New York, Stony Brook); Shimabukuro, F. I. Astrophys. J.; 168: No. 3, 525-9(15 Sep 1971).

The solar oscillatory component was observed at a wavelength of 3 mm by its modulation of the solar free–free emission. The observations were carried out separately at 3.3 and 3.5 mm with two different radio telescopes to rule out possible instrumental and atmospheric effects. Power spectra of the data show that the strongest spectral component is at 5.5×10^{-3} Hz (period 180 s). These observations indicate that it is possible, by radio techniques, to extend observations of the solar oscillatory component to higher heights in the solar atmosphere than those previously observed in photospheric and low chromospheric spectral lines. (auth)

52562 OBSERVATION OF NONTHERMAL SOLAR X RADIATION IN ENERGY RANGE $3 < E < 10$ keV. Kahler, S. W.; Kreplin, R. W. (Naval Research Lab., Washington, D. C.). Astrophys. J.; 168: No. 3, 531-41(15 Sep 1971).

The low-energy (3 to 10 keV) x-ray spectra observed during solar impulsive bursts of $E > 10$ keV x rays reported by Kane and Anderson are analyzed. In two of these bursts one can separate the total low-energy x-ray emission into thermal and nonthermal components. The inferred nonthermal electron spectrum is discussed in relation to acceleration by electric fields. The electron spectrum allows a determination of the minimum value of E_f/n_e, the ratio of electric field strength to electron density. (auth)

52563 INTERPRETATION OF INTERPLANETARY SCINTILLATIONS. Young, A. T. (California Inst. of Tech., Pasadena). Astrophys. J.; 168: No. 3, 543-62(15 Sep 1971).

Radio observations of interplanetary scintillations are interpreted by means of a theory previously used for the detailed interpretation of optical observations of atmospheric scintillations. The theory allows a number of restrictive assumptions to be removed, and thus gives a more realistic picture of the interplanetary medium and a more accurate representation of the observations. Observers are requested to report power spectra of the logarithm of the intensity, to avoid artifacts due to "spikes". (auth)

52564 OBSERVATION OF THE ANGULAR-MOMENTUM FLUX CARRIED BY THE SOLAR WIND. Lazarus, Alan J.; Goldstein, Bruce E. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 168: No. 3, 571-4(15 Sep 1971).

Using data from the Mariner 5 spacecraft, the angular-momentum flux carried by the solar wind was measured and found to be in agreement with earlier estimates based on observations of the deflection of comet tails. (auth)

52565 SOLAR WIND FOR A MAGNETIZED PLASMA WITH TENSOR PLASMA PRESSURE. Tan, Muser L. Mu-shen. St. Louis; Washington Univ. (1971). 130p. University Microfilms Order No. 71-19,847.

Thesis.

A model is presented of the quiet-day solar wind including a self-consistent magnetic field, an azimuthal flow velocity, and an anisotropic plasma pressure. The fully ionized solar-wind plasma consisting of 95.5% hydrogen ions, 4.5% helium ions and electrons is described by the hydromagnetic equations for a collisionless plasma in a strong magnetic field. These equations are a variation of the Chew–Goldberger–Low equations where new polytrope laws, functions of mass density and magnetic-field magnitude, replace the energy equation. The precise form of the energy equation is unknown since the solar-wind heating by mechanical waves is only understood qualitatively. The polytrope laws are chosen to reduce to the CGL double adiabatic equations of state in one limit and to the isothermal equation of state in another limit affording a relatively easy comparison with previous models. The choice also makes the momentum equation integrable. Numerical results for several cases for the fluid and magnetic field variables at the orbit of the Earth with certain boundary conditions at the Sun agree with experimental data for most quantities. The radial flow of the solar wind is not much affected by the magnetic field and pressure anisotropy. However, the shear stress due to the pressure anisotropy plays an important role in the transfer of angular momentum from the magnetic field to the solar-wind particles. All the angular momentum is transferred to the solar-wind particles at the onset of the fire-hose instability. The azimuthal velocity with the additional effect of the anisotropic pressure stress in the angular momentum equation is increased to about 10 km/sec, which is a value consistent with satellite and comet tail data. The possible improvement of the results for some variables using a two-fluid model with electrons that are hotter and less anisotropic than the ions is briefly discussed. (Diss. Abstr. Int., B)

52566 LINE TRANSFER IN THE PRESENCE OF TWO-DIMENSIONAL VELOCITY GRADIENTS. Cannon, C. J.; Rees, D. E. (Univ. of Sydney). Astrophys. J.; 169: No. 1, 157-63 (1 Oct 1971).

Feautrier's (1964) method is generalized to solve the equation of radiative transfer for a spectral line in an atmosphere exhibiting horizontal fluctuations in all physical parameters together with multi-dimensional velocity gradients. Model two-dimensional velocity problems are discussed. (auth)

52567 RADIAL ELECTRIC FIELD IN THE SOLAR WIND. Cuperman, S.; Harten, A. (Tel-Aviv Univ., Israel). Astrophys. J.; 169: No. 1, 165-9(1 Oct 1971).

The radial electrostatic field in the solar wind, which is responsible for the equality of the electron and positively charged ion fluxes observed at about 1 A.U. as well as for the quasi-charge neutrality of the Sun, is calculated. This is achieved by using expressions for particle density, bulk velocity, and electron and proton temperatures obtained from a two-fluid model with modified transport coefficients. The modifications of transport coefficients are purely phenomenological and are determined by the requirement that the predicted gross features of the solar wind match the available observations. Effects such as solar rotation, magnetic field, viscosity, and fluctuations are neglected. The results indicate radial electric fields ranging between 1.4×10^{-8} V cm^{-1} at 1 $R_\odot$ and 2.3×10^{-12} V cm^{-1} at 1 A.U. The total radial electrostatic potential between 1 $R_\odot$ and 1 A.U. is found to be about 1200 V. The possibility of using the results obtained for the interplanetary radial electric field in order to calculate some basic features of other ionic species in the solar wind is indicated. Because of their small relative contribution, the electrostatic radial field based on the two-fluid model should represent a satisfactory approximation. (auth)

Galaxies

Refer also to abstract 53344.

52568 KINEMATIC-DYNAMO ACTION UNDER INCOMPRESSIBLE, ISOTROPIC VELOCITY TURBULENCE. Lerche, I.; Low, B.-C. (Univ. of Chicago). Astrophys. J.; 168: No. 3, 503-8(15 Sep 1971).

It is demonstrated that incompressible, isotropic velocity turbulence on its own in an infinite medium leads to regenerative dynamo action. Earlier work has demonstrated that (i) incompressible velocity turbulence possessing a net helicity generates dynamo action in an infinite medium; (ii) isotropic, compressible velocity turbulence generates dynamo action in an infinite medium. The present results show first that regenerative dynamo action is not peculiar to the assumption of either nonisotropy or compressibility, and second that the turbulent Lorentz force (which is never isotropic no matter whether the velocity turbulence is isotropic or not) is the main cause of purely turbulent dynamo action. The fact that incompressible, isotropic turbulence generates dynamo activity just underscores these facts. (auth)

52569 DYNAMICS OF THE PERSEUS CLUSTER OF GALAXIES. Chincarini, Guido; Rood, Herbert J. (Wesleyan Univ., Middleton, Conn.). Astrophys. J.; 168: No. 3, 321-5(15 Sep 1971).

Carnegie image-tube spectra obtained in November 1970 with the 84-inch telescope of the Kitt Peak National Observatory have yielded radial velocities for forty-two more galaxies in a central region of the Perseus cluster. This brings the total number of known velocities to forty-nine. Since their frequency distribution of velocities is nearly Gaussian, the entire sample is treated as cluster members. The average velocity (relative to the Local Group of galaxies) is $\langle V_0 \rangle = 5460 \pm 200$ km s^{-1}. The standard deviation is $\sigma v_0 = 1420 \pm 140$ km s^{-1}, the largest of any cluster studied up to the present. NGC 1265, a prominent galaxy whose membership is indicated by radio observations, has a radial velocity $V_0 = 7660$ km s^{-1} which is 2370 km s^{-1} larger than the velocity of NGC 1275, the luminous Seyfert member. To prevent the escape of NGC 1265, and to stabilize the cluster, its mass must be about 10^{15} $M_\odot$. Otherwise, the large-velocity dispersion and the asymmetrical structure of the cluster imply instability, with an expansion age about 3×10^8 years, which seems to be in conflict with the observed late-type spectra. (auth)

52570 EVIDENCE FOR COMPOSITION GRADIENTS ACROSS THE DISKS OF SPIRAL GALAXIES. Searle, Leonard (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J.; 168: No. 3, 327-41(15 Sep 1971).

The integrated spectra of H II regions located in the inner spiral arms of Sc galaxies are systematically different from those of H II regions in the outer arms. This is, in part at least, an abundance effect. The N/O ratio (and probably also the abundance ratios O/H and N/H) decreases from the inner to the outer arms. (auth)

52571 NUMERICAL EXPERIMENTS WITH A DISK OF STARS. Hohl, Frank (Langley Research Center, Hampton Va.). Astrophys. J.; 168: No. 3, 343-59(15 Sep 1971).

The evolution of an initially balanced rotating disk of stars with an initial velocity dispersion given by Toomre's local criterion was investigated by means of a computer model for isolated disks of stars. It was found that the disk is unstable against very large-scale modes. After about two rotations the central portion of the disk tends to assume a bar-shaped structure. A stable axisymmetric disk with a velocity dispersion much larger than that given by Toomre's criterion is generated. The final mass distribution for the disk gives a high-density central core and a disk population of stars that is closely approximated by an exponential variation. (auth)

52572 ELECTRON DENSITY AND TEMPERATURE IN THE DIFFUSE INTERSTELLAR MEDIUM DETERMINED FROM RECOMBINATION LINES. Gordon, M. A.; Gottesman, S. T. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 168: No. 3, 361-71(15 Sep 1971).

An analysis is presented of the H157α and H197β radio recombination lines from regions near the galactic plane believed to be free of discrete radio sources. The results are consistent with a distribution of H II having a mean temperature of approximately 10^3°K and a mean emission measure of 280 pc cm^{-6} over a path length of 14 kpc, and thus a lower limit of approximately 0.15 cm^{-3} to the rms electron density. The ionization appears to be confined to galactic radii less than ~8 to 10 kpc, and to be excluded from regions within 2 kpc of the Sun. The medium appears to be clumped to some extent. (auth)

52573 IONIZATION EQUILIBRIUM OF INTERSTELLAR NITROGEN: PROBE FOR THE INTERCLOUD MEDIUM. Steigmnan, Gary (Inst. of Theoretical Astronomy, Cambridge, Eng.); Werner, Michael W.; Geldon, Fred M. Astrophys. J.; 168: No. 3, 373-80(15 Sep 1971).

Using the orbiting-collision approach devised by Field and Steigman, the rate coefficients for the charge-exchange reactions $N^+ + H \rightleftharpoons N + H^+$ were calculated for temperatures between 10° and 10^4°K. It was found that the ionization equilibrium of nitrogen in interstellar space is strongly influenced by this charge-exchange process. The degree of ionization of nitrogen approaches or exceeds that of hydrogen in a hot, partially ionized intercloud medium, but falls well below it in the clouds. The N II resonance line at 1084 Å will thus be formed only in the intercloud medium, and its strength is shown to be a sensitive indicator of the temperature of this region. (auth)

52574 NATURE OF THE GALAXY IDENTIFIED WITH 3C 386. Lynds, Roger (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 168: No. 3, L87-9(15 Sep 1971).

New spectroscopic and photometric observations indicate that Griffin's optical identification for 3C 386 is a galaxy with a foreground galactic star superposed. The galaxy has a redshift of 0.0177 and an absolute visual magnitude of at least –20. (auth)

52575 SPUTTERING OF ICE GRAINS IN H II REGIONS. Barlow, M. J. (Univ. of Sussex, Brighton, Eng.). Nature (London) Phys. Sci.; 232: No. 33, 152-3(16 Aug 1971).

Reference is made to Mathews (Astrophys. J., 157: 583(1969)) who derived expressions based on the experimentally verified concept of sputtering as an energy transfer process, describing the sputtering of thermal ions of grains in H II regions, and it is stated that there is an error in one of these expressions that leads to a considerable overestimate of the effect of sputtering on interstellar grains. It is concluded that ice grains, if they exist, are unlikely to be significantly affected by sputtering in H II regions. (UK)

52576 OPTICAL PROPERTIES OF GRAPHITE–IRON–SILICATE GRAIN MIXTURES. Wickramasinghe, N. C. (Inst. of Theoretical Astronomy, Cambridge, Eng.); Nandy, K. Mon. Notic. Roy. Astron. Soc.; 153: No. 2, 205-27(1971).

The mean optical properties of mixtures of particles consisting of graphite, iron, and silicates were computed using the Mie theory for spherical particles. Mixtures with individual components contributing more or less equally to the optical extinction are shown to provide good fits to the observed interstellar extinction curve including the characteristic graphite feature at $\lambda^{-1} \cong 4 \cdot 4\ \mu^{-1}$. The same mixtures are able to account for the observed 10-μ silicate band in the extinction while also fitting the data on the diffuse galactic light at optical and ultraviolet wavelengths. The models are also consistent with the available data on the backscattering properties of grains. (auth) (UK)

52577 RATIO OF TOTAL TO SELECTIVE EXTINCTION AND THE DISTANCE TO THE GALACTIC CENTRE. Martin, P. G. Mon. Notic. Roy. Astron. Soc.; 153: No. 2, 251-60(1971).

A method for determining R, the ratio of total to selective extinction, is discussed. It is shown that reliable distances, expressed as a fraction of the distance ρ_0 to the galactic centre, can be calculated from radial velocities and a model for the differential rotation of the Galaxy when care is taken to select suitable stars. A measure of the total extinction can be derived when the apparent distance modulus is known. From the slope of a graph of this extinction against color excess for many stars, an average value of R is determined; the intercept gives ρ_0. In this paper R = A_V/E_{B-V} on the UBV color system. From a total of 180 OB stars, Cepheids, and galactic clusters R is found to be $3.3^{+0.7}_{-0.5}$ and ρ_0 lies in the range 8 to 10 kpc. (auth) (UK)

52578 DISPERSION OF ELECTROMAGNETIC WAVES IN INTERSTELLAR SPACE. Lee, A. R. (La Trobe Univ., Melbourne). Phys. Lett.; 36A: No. 4, 283-4(13 Sep 1971).

Attention is drawn to the fact that the dispersion effect of electromagnetic waves in a plasma is indistinguishable in form from that due to assigning a nonzero rest mass to the photon. (auth)

52579 SEARCH FOR EXTRAGALACTIC H_2O. Dickinson, Dale F. (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Chaisson, Eric J. Astrophys. J.; 169: No. 1, 207-8 (1 Oct 1971).

Three giant H II regions in M33 examined for 22-GHz H_2O emission showed no maser as intense as the one in W49. (auth)

52580 DIFFUSE COSMIC X-RAY FLUX FROM 0.2 TO 2 keV. Palmieri, T. M.; Burginyon, G. A.; Grader, R. J.; (and others) (Univ. of California, Livermore). Astrophys. J.; 169: No. 1, 33-9(1 Oct 1971).

Observations of the low-energy diffuse x-ray background were made with a new detector system sensitive in the range from 0.2 to 2 keV. An electrostatic rejection system was used to eliminate electrons as a source of non-x-ray background. The spectrum above 2 keV agreed with that reported by other authors. The spatial distribution of the flux below 1 keV is complicated. Possible interpretations are discussed. The flux at 0.25 keV is basically in agreement with that obtained by other authors. In the region of sky covered by this observation, the variation of flux with galactic latitude implies a galactic origin for most of the diffuse soft x-rays. (auth)

Cosmology

Refer also to abstracts 53315 and 53337.

52581 RADIATIVE VISCOSITY IN RELATIVISTIC MEDIUM. Haemeen-Anttila, K. A.; Suhonen, E. (Univ. of Oulu, Finland). Ann. Acad. Sci. Fenn., Ser. A VI; No. 359, 1-16(1971).

The expression for radiative viscosity is derived from general-relativistic considerations. In the special-relativistic limit, the resulting coefficient of viscosity differs from Thomas' expression commonly used in astrophysical literature. The deviation arises from an inaccurate approximation used in Thomas' work. (auth) (Finland)

52582 DISTRIBUTION OF QUASI-STELLAR SOURCES AND RELATED OBJECTS IN THE SKY. Virtanen, T. (Univ. of Oulu, Finland). Ann. Acad. Sci. Fenn., Ser. A VI; No. 353, 1-12(1970).

The distributions of quasi-stellar sources with large redshifts and Seyfert galaxies are shown to be very similar. This suggests a local origin for redshifts. The scattering of apparent magnitudes gives support to the same conclusion. (auth) (Finland)

52583 WORLD LINES OF DUST IN C-FIELD COSMOLOGY. Faulkes, M. C. (Queen's Univ., Kingston, Ont.). Commun. Math. Phys.; 20: No. 2, 123-9(1971).

Geodesic and nongeodesic world lines of dust were investigated in Pryee's C-field cosmology. A Raychaudhuri-type equation was derived for the nongeodesic, rotational dust flow. (auth)

52584 RADIATION AND ENERGY IN AN ASYMPTOTICALLY FRIEDMANN SPACE–TIME. Glass, Edward N. (Aerospace Re-

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search Labs., Wright Patterson AFB, Ohio). J. Math. Phys. (N. Y.); 12: No. 7, 1222-30(Jul 1971).

A bounded gravitating system in an asymptotically hyperbolic Friedmann space is examined. The Bondi–Metzner–Sachs (BMS) group is shown to be the asymptotic symmetry group. The BMS generators and the Weyl tensor are used to construct an asymptotic invariant which allows the energy of the gravitating system to be calculated without infinite contributions from the cosmological dust. It is shown that a bounded gravitating system in a cosmological space can be understood in much the same manner as a similar physical system in an asymptotically flat space–time. (auth)

52585 SPATIALLY HOMOGENEOUS ROTATING WORLD MODELS. Ozsvath, Istvan (Univ. of Texas, Dallas). J. Math. Phys. (N. Y.); 12: No. 7, 1078-82(Jul 1971).

The Lagrangian function is derived for four different rotating universes simultaneously. These models correspond in a certain sense to Gödel's "symmetric case." (auth)

52586 HUBBLE CONSTANT AND X RAYS FROM GALAXY CLUSTERS. Noerdlinger, P. D. (New Mexico Inst. of Mining and Tech., Socorro). Nature (London); 232: No. 5310, 393 (6 Aug 1971).

The theme of this brief communication is that the measured x-ray limits on clusters of galaxies do not necessarily imply that the virial theorem is inapplicable. The data have been said to limit the mass of hot gas in these clusters to 2% of that required for stabilisation according to the virial theorem, but such a conclusion is strongly dependent on the value of the Hubble constant (H_0). The linear diameter of the cluster (D) and the cluster mass (M), estimated by the virial theorem, both vary as H_0^{-1}, and hence the density (ρ) varies as H_0^2. The predicted x-ray flux from the gas is given by $\rho M/R^2$, where R is the distance to the cluster, and R varies as H_0^{-1}, giving the relation $F \sim H_0^3$. It is estimated that a value H_0 = 38 km/sec/Mpc would suffice to give agreement with the virial theorem for the Coma Cluster. The stabilisation of clusters of galaxies by ionised gas is questioned. (UK)

52587 INTERACTION OF GRAVITATIONAL RADIATION WITH AN INVISCID FLUID IN SIMPLE MOTION. Esposito, F. Paul (Univ. of Chicago). Astrophys. J.; 168: No. 3, 495-502 (15 Sep 1971).

The equations which govern the response of an inviscid fluid to an incident gravitational wave are derived and solved in the case of a uniform, incompressible fluid in uniform motion. This response naturally separates into a volume effect due to the prevailing kinetic energy of the fluid, and a surface effect, of the character of a gravity wave, due to the variation of the gravitational wave over the surface of the fluid. The interaction is found to be purely reactive; the fluid does not extract energy from the gravitational wave. (auth)

52588 EXTRAGALACTIC FARADAY ROTATION. Arp, H. (California Inst. of Tech., Pasadena). Nature (London); 232: No. 5311, 463-5(13 Aug 1971).

Reference is made to some recent papers purported to present evidence indicating that Faraday rotation is taking place in space outside the Galaxy and to show that above low galactic latitudes, where material in the galactic disk is known to produce Faraday rotation, extragalactic radio sources show Faraday rotations that generally increase with redshift and that these rotations behave similarly in certain regions of the sky. The extragalactic Faraday rotation is attributed to a metagalactic magnetic field ordered on the scale of the observable Universe (the scale observable on the assumption that the redshifts of quasars are cosmological). It seems to the present author, however, that this model is not the most likely one with which to explain the rotations, and an alternative model is presented, based on consideration of superclusters of galaxies in the supergalactic plane. (UK)

52589 CONFORMALLY PLANE GRAVITATIONAL FIELDS CREATED BY MATTER. Vashchuk, V. I. Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 11, 67-73(1969). (In Russian).

The geometric property (spherical symmetry) unequivocally distinguishing homogeneous cosmological models (Friedmann spaces) from others with conformally plane gravitational fields is indicated. Certain general distribution properties and the movements of material in conformally plane gravitational fields are established, and new solutions of Einstein's equations are obtained. (tr-auth)

52590 MODEL OF MIXMASTER UNIVERSE WITH ARBITRARILY MOVING MATTER. Grishchuk, L. P.; Doroshkevich, A. G.; Lukash, V. N. Zh. Eksp. Teor. Fiz.; 61: No. 1, 3-14 (Jul 1971). (In Russian).

Evolution of a cosmological model of a mixmaster universe filled with arbitrarily moving matter is considered. The investigation is performed for a coordinate system in which the matrix of n-hedral components of the three-dimensional metric tensor is reduced to the major axes. Movement of matter results in rotation of this coordinate system, the rotation rate slowing down on approach to a singularity. The total rotation angle during the time of evolution of the model is finite. It is shown that, even if motion of matter is taken into account, light during the strong anisotropy stage cannot traverse the world in any direction. Mixing therefore does not occur. Some necessary conditions for isotropization of the model at late expansion stages are obtained. (auth)

52591 OSCILLATORY MODE OF APPROACH TO A SINGULARITY IN HOMOGENEOUS COSMOLOGICAL MODELS WITH ROTATING AXES. Belinskii, V. A.; Lifshits, E. M.; Khalatnikov, I. M. (Inst. of Physical Problems, Moscow. Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 6, 1969-79(Jun 1971). (In Russian).

A homogeneous cosmological model of the Bainchi IX type, which is more general than that previously considered and in which the $\gamma_{ab}(t)$ coefficient matrix in the space metric contains off-diagonal elements, is studied. The presence of such elements does not alter the general oscillatory character of evolution of the model on approach to a singularity but does result in rotation of axes of the alternating Kasner epochs. In homogeneous models this phenomenon can exist only in the presence of matter. Some general considerations are presented regarding a possible relation to the properties of the general inhomogeneous solution of the Einstein equations for empty space as well as for space filled with matter. (auth)

52592 SURVEY OF COSMOLOGY: IS "OUR WORLD" IMPLIED BY THERMAL EQUILIBRIUM IN THE HADRON ERA. Kundt, Wolfgang (Univ., Hamburg). Springer Tracts Mod. Phys.; 58: 1-47(1971).

A discussion is given in some detail on why the Einstein–de Sitter model with $0 = \Lambda = \epsilon = Q = B = L_e = L\mu$ is a very suggestive one (Q = charge, B = baryon number, L_j = lepton numbers). An attempt is made to sketch how thermodynamics in this model can explain present observations. The survey deviates in parts from other publications, mainly in the treatment of baryon separation, and its consequences. Main topics considered include coarse-grained world geometry, thermal history, and fine-grained cosmology. (W.D.M.)

52593 THEORETICAL FRAMEWORKS FOR TESTING RELATIVISTIC GRAVITY. III. CONSERVATION LAWS, LORENTZ INVARIANCE, AND VALUES OF THE PPN PARAMETERS. Will, Clifford M. (California Inst. of Tech., Pasadena). Astrophys. J.; 169: No. 1, 125-40(1 Oct 1971).

The Parametrized Post-Newtonian (PPN) formalism is used to prove that metric theories which have post-Newtonian integral conservation laws for energy, momentum, angular momentum, and center-of-mass motion must be of a particular form, i.e., their PPN parameter values must obey certain constraints. These constraints leave only two PPN parameters freely specifiable. It is also shown that the post-Newtonian metric of any theory of gravity is invariant under a post-Galilean transformation if and only if its PPN parameters Δ_1, Δ_2, β_1, and ζ satisfy a set of constraints. A theory which satisfied these parameter constraints would then give the same results for any computation involving gravity, no matter what asymptotically Lorentz coordinate systems were used. For theories which do possess conservation laws, the transformation properties of the conserved integral quantities under post-Galilean transformations are determined. (auth)

52594 RELATIVISTIC GRAVITY IN THE SOLAR SYSTEM. II. ANISOTROPY IN THE NEWTONIAN GRAVITATIONAL CONSTANT. Will, Clifford M. (California Inst. of Tech., Pasadena). Astrophys. J.; 169: No. 1, 141-55(1 Oct 1971).

The Parametrized Post-Newtonian formalism is used to show that some theories of gravity predict an anisotropy in the Newtonian gravitational constant G, as measured locally by means of Cavendish experiments. Two such theories are Whitehead's theory and a theory of gravity (devised in this paper) which predict different flat-space propagation speeds for gravity and for light. The ansiotropy in G causes the local gravitational acceleration, measured by a gravimeter at a fixed point on Earth, to vary with a period of 12 sidereal hours as the Earth rotates. Gravimeter data (measurements of "Earth tides") are shown to put a limit of $1/10^9$ on the amplitude of any such anisotropy. This rules out Whitehead's theory which predicts an effect 200 times larger than the experimental limit. It also shows that the PPN parameter combination $(\Delta_2 + \zeta - 1)$ is zero to within 3%, and hence that the speeds of gravity and of light in the theory devised in this paper should be equal to within about 2%. (auth)

52595 DENSITY OF INTERGALACTIC DUST: AN UPPER LIMIT. Nickerson, Bruce G. (Princeton Univ., N. J.); Partridge, R. B. Astrophys. J.; 169: No. 1, 203-5(1 Oct 1971).

Recently reported values of the magnitude and redshift of distant galaxies are used to set a limit on the total absorption by intergalactic dust. It is then shown that the density of such dust is likely to be well below the cosmologically critical density of 1.8×10^{-29} g cm^{-3}. (auth)

Planetary Phenomena

Refer also to abstract 53333.

52596 CHEMICAL COMPOSITION OF APOLLO 14 SOILS 14163 AND 14259. Schnetzler, C. C.; Nava, D. F. (Goddard Space Flight Center, Greenbelt, Md.). Earth Planet. Sci. Lett.; 11: No. 5, 345-50(Aug 1971).

Major and minor element concentrations were determined by atomic absorption spectrophotometry and isotope dilution in Apollo 14 soils 14163 and 14259. The two soils have quite similar compositions. These soils have higher Si, Al, K, rare earths, Ba, Li, Rb, Zr, and Hf, and lower Fe, Ti, Mn, and Cr concentrations than soils from the mare areas sampled by Apollo 11, Apollo 12, and Luna 16. They most closely resemble in chemical composition the exotic fragments, such as KREEP or norite, found in Apollo 11 and 12 soils, or the dark portion of rock 12013. Similarities between chemical characteristics of Apollo 12 soils and breccias, rock 12013, and the two Apollo 14 soils suggest that extensive quantities of Fra Mauro material have been transferred to the Apollo 12 mare site. The data are consistent with the hypotheses that the pre-mare crust of the Moon is the result of extreme differentiation or the Moon accumulated inhomogeneously. (auth)

52597 DETERMINATION OF 36 ELEMENTS IN APOLLO 14 BULK FINES 14163 BY ACTIVATION ANALYSIS. Brunfelt, A. O. (Mineralogisk-Geologisk Museum, Oslo); Heier, K. S.; Steinnes, E.; Sundvoll, B. Earth Planet. Sci. Lett.; 11: No. 5, 351-3(Aug 1971).

Thirty-six elements were determined in Apollo 14 bulk fines 14163. A one gram bulk sample was split from the 4.960 grams received of sample 14163, 154, and analyzed according to the method described by Brunfelt and Steinnes (Talanta in print) with some slight modifications. (W.D.M.)

Atomic and Molecular Physics

Refer also to abstract 53788.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 52888, 53337, 53660, and 53752.

52598 (LB/G-3055) TYPES OF WAVES IN MAGNETICALLY FOCUSSED ELECTRON BEAMS. Poetzl, Hans. Translated by W. G. Stripp (Atomic Energy Research Establishment, Harwell, Eng.), from Arch. Elek. Uebertrag.; 19: 367-83(1965). 46p. Dep. NTIS (U. S. Sales Only).

Three types of kinetic waves can be distinguished in electron beams where transverse motion is not suppressed by the guiding magnetic field: (1) Oscillations at the plasma frequency propagate as space-charge waves. (2) The magnetic flux through the cathode, which produces a vortex of the generalized momentum, gives rise to the appearance of the vortical waves. Also in this case, the convective propagation of waves is involved whose resonant frequency (vortical frequency) is a measure of the magnetic flux through the cathode. (3) For a weak magnetic flux through the cathode the transverse freedom of motion of the electrons is large enough to allow the propagation of surface waves where a distortion of the beam cross section or a motion of the hypothetical center of the cross section guides the excitation. Corresponding modes appear in the plasma flow where the steady-state space-charge density is offset by ions. The magnetic field in the flow takes the place of the density of the magnetic flux through the cathode, however. It is proven that, from the standpoint of an observer traveling along, the waves in the electron beam and the plasma flow are equivalent. In the irrotational Brillouin beam the vortical waves degenerate to a force-free motion with constant velocity, which can only be excited at the cathode. The cyclotron and synchronous waves, which were derived approximately by reference to the pencil-beam model or from the motion of the center of the cross section, are obtained as surface waves for beams of arbitrary thickness. (auth)

52599 (SGAE-PH-109/1971) DETERMINATION OF THE SPUTTERING YIELD AND OF THE SECONDARY ELECTRON YIELD OF SILICON CARBIDE, PYROCARBON, AND GRAPHITE FOR 30-keV AND 12-keV ARGON IONS AT NORMAL INCIDENCE. Pichlmayer, F. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). [1970]. 6p. Dep. NTIS (U. S. Sales Only).

These measurements were made to investigate: (1) the dependence of the sputtering yield on target material, primary ion energy, residual gas pressure, and current density as a preexperiment for developing a sputter apparatus; (2) the secondary electron yield for the purpose of target material identification; and (3) the rate of removal of PyC and SiC layers by the sputtering process for better interpretation of the fission-product concentration profile within coated fuel particles. (auth)

52600 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 6, NO. 6, 1971. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 59p.

This listing includes 199 references on various aspects of surface and vacuum physics as related to atomic physics. (M.O.W.)

52601 MEASUREMENT AND APPLICATION OF PROTON-INDUCED X-RAY EMISSION FROM THIN FILMS. Reuter III, Frederic William. Berkeley, Calif.; Univ. of California (1970). 60p. University Microfilms Order No. 71-20,896.

Thesis.

An expression for characteristic x-ray production by low-energy protons is developed relating multi-component, elemental thin-film surface densities to proton stopping power, x-ray production cross section, and x-ray attenuation. Thin- and thick-target oxygen K-shell x-ray yields from anodized, tantalum-oxide thin films were measured experimentally from 20 to 80 keV. The oxygen K-shell x-ray production deviates from the prediction based on the Born approximation, but are in agreement with other experimental determinations. The 525-eV aluminum oxide and tantalum oxide x-ray attenuation coefficients are $1.35 \pm 0.05 \times 10^{-4}$ and $5.3 \pm 1.4 \times 10^{-2}$ cm^2/μg of oxide, respectively. These values are greater than those predicted by chemical additivity. The equilibrium oxide anodization voltage of tantalum oxide grown in air is 6.97 ± 0.01 volts. Careful consideration of previously reported values of aluminum oxide proton stopping power indicates they should be reduced by a factor of $\sqrt{2}$, corroborating the results of other investigators who have found deviations from the Bragg law at low energies. (Diss. Abstr. Int., B)

52602 ON THE ELASTIC AND INELASTIC SCATTERING OF NEON ATOMS BY A (100) SURFACE OF LITHIUM FLUORIDE AT 150^0K. Williams, Brian R. (National Research Council of Canada, Ottawa). J. Chem. Phys.; 55: No. 3, 1315-22(1 Aug 1971).

Results are presented for the scattering of neon atoms (obtained from a nozzle source) from a cleaved surface of lithium fluoride maintained at 150°K. The scattering patterns reveal well-defined peaks resulting from coherent scattering. Inelastic scattering is also observed: (1) scattering due to the thermal motions of surface atoms giving streaks extending in the ⟨100⟩ direction from the elastic peaks; (2) incoherent or cosine scattering. A brief comparison with the scattering of argon atoms is made. (auth)

52603 DIFFERENTIATION IN L-SUBSHELL VACANCY PRODUCTION IN IODINE IONS BY ATOMIC COLLISIONS AT 15 TO 60 MeV. Datz, S.; Moak, C. D.; Appleton, B. R.; Carlson, T. A. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 27: No. 7, 363-6(16 Aug 1971).

A study of the iodine L-x-ray spectra arising from collisions of 15- to 60-MeV ^{127}I ions with target atoms ranging from carbon to lead ($Z_2 = 6$ to 82) shows large systematic variations in the relative number of vacancies produced in the $2p_{1/2}$ and the $2p_{3/2}$ subshells. (auth)

52604 ATOMIC BEAM SOURCES. Glavish, H. F. (Stanford Univ., Calif.). pp 267-93 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

Demand for an increase in beam current to offset loss upon injection and acceleration has stimulated much recent work in source development. This work is reviewed under the following topics: nozzle design, separating magnet, radio-frequency transitions, ionization, negative ions, spin precession, and injection and acceleration. 86 references. (L.M.T.)

Atomic and Molecular Properties

Refer also to abstracts 52522, 52549, 52694, 52695, 52699, 52810, 52942, and 52943.

52605 (CONF-711001-(Vol.1), pp 35-51) THEORETICAL TREATMENT OF THE ENERGY DIFFERENCES BETWEEN $f^qd^1s^2$ AND $f^{q+1}s^2$ ELECTRON CONFIGURATIONS FOR LANTHANIDE AND ACTINIDE ATOMIC VAPORS. Nugent, L. J.; Vander Sluis, K. L. (Oak Ridge National Lab., Tenn.). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The differences between the lowest energy level of the $f^qd^1s^2$ electron configuration and the lowest energy level of the $f^{q+1}s^2$ electron configuration for the metal vapors of 9 members of the lanthanide series and 4 members of the actinide series are shown to be neatly and simply correlated by an adaptation of Jørgensen's refined electron-spin-pairing energy theory. The theory is also used to extrapolate the corresponding energy differences for those lanthanide and actinide metal vapors for which this information was previously undetermined. The results will be helpful as a guide in making spectral assignments, and they are generally useful in correlating the thermodynamic properties of the chemical compounds of the lanthanide and actinide series. The theoretical basis of the treatment should also be applicable for correlating the relative energies of other electron configurations in these metal atoms and ions. (auth)

52606 (CONF-711001-(Vol.1), pp 64-72) INFRARED SPECTRA OF RARE EARTH β-DIKETONATES. Mehta, P. C.; Tandon, S. P. (Jodhpur Univ. (India). Dept. of Physics). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The infrared absorption spectra of rare earth β-diketonates were measured in the spectral region 4000 to 250 cm^{-1}. The β-diketones used in the preparation of the chelates include acetylacetone, benzoylacetone, dibenzoyl methane, and thenoyltrifluoroacetone. All the spectra were interpreted by considering a 1 : 1 (metal/ligand) complex having a C_{2v} symmetry. The existence of three metal-sensitive vibration modes suggests a D_3 symmetry for all the chelates. The M–O stretching frequency shifts to higher values with the increase of the mass of the central rare earth ion. The metal–oxygen force constants were computed using a simple O–M–O model of the chelates. The values of the M–O stretching force constant reveal that, among all the chelates studied, the acetylacetone has the largest affinity towards the complex formation. (auth)

52607 (CONF-711001-(Vol.1), pp 135-43) SOFT X-RAY SPECTROSCOPY APPLIED TO THE STUDY OF 4f STATE DISTRIBUTIONS IN RARE EARTH METALS AND THEIR ALLOYS. Karnatak, Ramesh C.; Bonnelle, C. (Paris Univ. (France). Laboratoire de Chimie Physique). 1971. (In French).

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The x-ray transitions between the inner $3d_{3/2}$ and $3d_{5/2}$ levels and the 4f state distributions in rare earth metals Ce, Eu, Gd, Dy, Yb, and their oxides provide original information on these distributions. The principal features, the 4f state modifications observed in different environments in these metals and oxides, and their positions with respect to the Fermi level of the metal, are given. (auth)

52608 REEVALUATION OF L_2-SUBSHELL COSTER–KRONIG TRANSITION PROBABILITY AND FLUORESCENCE YIELD BELOW Z = 81. McGeorge, J. C.; Mohan, S.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., A; 4: No. 3, 1317-18(Sep 1971).

Recently published experimental values of the L_2-L_3 total Coster–Kronig and L_2-subshell fluorescence yields for Z = 65, 70, 73, and 80 have been corrected for the presence of the unresolved L_η $[L_2-M_1]$ x-ray line in the L_α $[L_3-M_{4,5}]$ x-ray group. It is shown that this appreciable correction does not explain the discrepancy between experiment and theory. (auth)

52609 QUANTUM DEFECTS FOR He I AND Li II. Sheorey, V. B. (Univ. of Pittsburgh). J. Phys., B (London); 4: No. 6, L44-7(Jun 1971).

Quantum defects for He I and Li II obtained from an extrapolation of phase shifts for elastic scattering of electrons by hydrogenic positive ions are compared with those obtained from Z-expansion perturbation theory by Blanchard (1969). (auth) (UK)

52610 f VALUES FOR TRANSITIONS BETWEEN THE LOW-LYING S AND P STATES OF THE HELIUM ISOELECTRONIC SEQUENCE UP TO Z = 10. Schiff, B. (Tel-Aviv Univ., Ramat Aviv, Israel); Pekeris, C. L.; Accad, Y. Phys. Rev., A; 4: No. 3, 885-93(Sep 1971).

f values have been computed for the transitions m^1S-n^1P, m = 1 to 5, n = 2 to 5 and m^3S-n^3P, m, n = 2 to 5 for members of the helium isoelectronic sequence up to Z = 10. The agreement between the results obtained using the dipole length and velocity formulas, together with the convergence of the results as an increasing number of terms are included in the expansions of the wave function, indicates that the values obtained are accurate to within 1% or better for the large majority of the transitions. (auth)

52611 TWO-PHOTON DECAY RATE OF THE 2^1S_0 METASTABLE STATE OF HELIUM. Jacobs, Verne (Weizmann Inst. of Science, Rehovot, Israel). Phys. Rev., A; 4: No. 3, 939-44 (Sep 1971).

Two alternative expressions for the two-photon decay rate of the 2 $^1S_0$ metastable state of helium are evaluated by performing the summations over intermediate $^1P_1$ states. The values obtained from the "length" and "velocity" expressions for the decay rate are 50.85 sec^{-1} and 50.89 sec^{-1}, respectively, in good agreement with a recent experimental value and with previous calculations done by different methods. Incidental results are given for the photoionization cross sections of the 1 $^1S_0$ and 2 $^1S_0$ states of helium in the energy region 0 to 0.2 rydberg. (auth)

52612 STARK-PROFILE MEASUREMENTS FOR THE FIRST FOUR n-α LINES OF IONIZED HELIUM. Jones, L. A.; Greig, J. R.; Oda, T.; Griem, Hans R. (Univ. of Maryland, College Park). Phys. Rev., A; 4: No. 3, 833-8(Sep 1971).

Using an electromagnetically driven T tube as a source, the profiles of the He II 304-Å (n = 2 to 1), He II 1640-Å (n = 3 to 2), He II 4686-Å (n = 4 to 3), and He II 10 123-Å (n = 5 to 4) lines were scanned and compared with Stark broadening theory. The plasma conditions correspond to electron temperature from 4 to 5 eV and electron densities from 1×10^{17} to 3×10^{17} cm^{-3}. Agreement of measured relative intensities with theory is typically within ~30%, provided a distinction is made between absorption and emission line shapes of the resonance line in a singly ionized helium plasma. (auth)

52613 DOES THE COSTER–KRONIG TRANSITION PROBABILITY f_{23} HAVE A RADIATIVE COMPONENT? Chen, Mau Hsiung (Univ. of Oregon, Eugene); Crasemann, Bernd; Rao, P. Venugopala; Palms, J. M.; Wood, R. E. Phys. Rev., A; 4: No. 3, 846-9(Sep 1971).

The radiative magnetic dipole transition rate between $2p_{1/2}$ and $2p_{3/2}$ single-particle electron states was calculated with relativistic screened hydrogenic wave functions for seven elements with $70 \leq Z \leq 93$ and was found to contribute only $\sim 10^{-5}$ of the total L_2 level width. The result was corroborated by an experimental study of the Pb M x-ray spectrum in coincidence with $K\alpha_1$ and $K\alpha_2$ x rays, establishing a limit $\omega_{23} \lesssim (1.4 \times 3.0) \times 10^{-3}$ for the radiative part of the L_2-L_3X Coster–Kronig transition probability in Pb. (auth)

52614 SPLITTING OF THE $4d_{3/2}$ AND $4d_{5/2}$ LEVELS IN RARE-EARTH ELEMENTS. Salem, S. I.; Schultz, C. W.; Rabbani, B. A.; Tsutsui, R. T. (California State Coll., Long Beach). Phys. Rev. Lett.; 27: No. 8, 477-8(23 Aug 1971).

The existence of emission lines at the low-energy sides of the $L\beta_{2,15}$ and $L\lambda_1$ x-ray lines in the rare earth elements was experimentally detected. Their intensities and positions relative to those of the $L\beta_{2,15}$ and $L\gamma_1$ lines were measured and are presented as functions of the atomic number of these elements. (auth)

52615 EXCHANGE SPLITTING IN THE 4f PHOTOELECTRON SPECTRA OF THE RARE EARTHS. Wertheim, G. K.; Rosencwaig, A.; Cohen, R. L.; Guggenheim, H. J. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 27: No. 8, 505-7 (23 Aug 1971).

Splitting observed in the x-ray photoelectron spectra of rare earth ions with more than half-filled 4f shells is shown to arise from the exchange-energy difference between final 4f states. (auth)

52616 CALCULATION OF REPULSIVE ATOMIC-INTERACTION POTENTIALS FROM STATISTICAL THEORY. Nikulin, V. K. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 1, 28-33(Jul 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 1, 41-7(Jan 1971).

The use of different energy functionals in the statistical theory of the atom to calculate the total energy of the atomic shell and the interaction potentials was investigated. Programs were developed that permit the determination of the potentials of any atom or ion pair, using data on the electron density in the shells yielded by quantum mechanical calculations for the atoms. This paper presents the results of calculation of the interaction potentials of atoms in the ground state with excitation and ionization taken into account. These results are compared with quantum mechanical calculations and with data obtained from experiments on the elastic scattering of atomic beams. (auth)

52617 AB INITIO CALCULATIONS OF HARMONIC FORCE CONSTANTS. V. APPLICATION TO NATURAL EXPANSIONS. **Bishop, David M.; Macias, A. (Univ. of Ottawa). J. Chem. Phys.; 55: No. 2, 647-51(15 Jul 1971).**

The analytic method of calculating force constants is extended to handle wave functions built from the natural orbitals obtained from a configuration-interaction (CI) wave function. The method is applied to a series of wave functions for H_2. No correlation between the force constant and the degree of truncation of the natural expansion is detected. In a study of some rank-1 functions for H_2 (considered to be close to the self-consistent-field wave functions), it is found that the contribution to the force constant (k) from allowance for flexibility in the nonlinear parameters is important and that the k's for the rank-1 functions and CI wave functions (from which they are derived) are very similar. (auth)

52618 NONEMPIRICAL LCAO-MO-SCF STUDY OF THE ENERGY SURFACE FOR LINEAR HeH_2^+. **Brown, Peter J.; Hayes, Edward F. (Rice Univ., Houston, Tex.). J. Chem. Phys.; 55: No. 2, 922-6(15 Jul 1971).**

The nonempirical LCAO-SCF-MO method using a contracted Gaussian basis is used to generate a potential-energy surface for the ground state of the linear HeH_2^+ system. Recently, Chupka, Berkowitz, and Russell reported that even above threshold the cross sections for the reaction $H_2^+ + He = HeH^+ + H$ are strongly dependent on the vibrational state of the H_2^+ ion. Examination of the calculated potential-energy surface for this reaction reveals that the energy barrier for this reaction occurs very late in the exit channel. This result, coupled with the work of Polanyi and Wong on the effect of the position of the potential-energy barrier, suggests that this late energy barrier is the reason that vibrational energy is much more effective than translational energy in causing this reaction. Another interesting feature of the calculated potential-energy surface is the presence of a minimum corresponding to a HeH_2^+ complex. Investigation of the energy of this complex as a function of He-H-H bond angle demonstrates that the 180° form is the most stable. (auth)

52619 ELECTRON DISTRIBUTIONS FOR THE HELIUM-ATOM-HYDROGEN-MOLECULE SYSTEM. **Gordon, Michael D. (Jackson Lab., Wilmington, Del.); Secrest, Don; Llaguno, Claro. J. Chem. Phys.; 55: No. 3, 1046-53(1 Aug 1971).**

A study is made of the electron distribution generated by self-consistent-field wave functions for the hydrogen-molecule-helium-atom system. The electron density is studied by means of electron density contour plots and plots of the difference between the electron density for interacting hydrogen molecule and helium atom systems and the noninteracting hydrogen molecule and helium atom. A population analysis technique is applied to these wave functions. Though the population analysis is a rather unrealistic method of distributing the electrons among and between the nuclei, it appears to give a qualitatively correct description of the electron distribution. The wave function studied gives a potential surface on which the H_2 molecule tends to contract when the He atom approaches. This is true even when He approaches the H_2 at an angle of 90° to the internuclear axis. The population analysis reflects this effect by showing an increase in the H_2 bond population as He approaches. (auth)

52620 COLLAPSE OF SHOCK-BROADENED MULTIPLETS. **Strekalov, M. L.; Burshtein, A. I. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 61: No. 1, 101-11(Jul 1971). (In Russian).**

Collapse (merging) of spectral components due to averaging of the field by nonadiabatic collisions is considered in the special case of Stark structure of hydrogen and helium lines. It is shown that phase memory, which is responsible for the phenomenon, changes the magnitude of the broadening by several times under degeneracy conditions. Exchange narrowing of spectra is found to be an extreme case of collapse. (auth)

52621 SPONTANEOUS IONIZATION OF A HYDROGEN ATOM IN AN ELECTRIC FIELD. I. **Hirschfelder, Joseph O.; Curtiss, Larry A. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 55: No. 3, 1395-1402(1 Aug 1971).**

The time-independent Schrödinger equation expressed in parabolic coordinates for a hydrogen atom in an electric field was numerically integrated for the state $n = 5$, $n_1 = 3$, $n_2 = 0$, and $m = 1$ to obtain the resonance energy E_r and the rate of ionization τ^{-1} for field intensities ranging from 8×10^5 to 11×10^5 V/cm. It is found that near the resonance energy τ^{-1} varies quadratically with $(E - E_r)^2$ in accordance with the well-known Weisskopf-Wigner treatment of metastable states. When E is nearly equal to E_r, the wave function has a node at the outer turning point—no explanation is offered. At the very high field intensities considered, there was considerable difference between E_r and the energy calculated by Rayleigh-Schrödinger perturbation theory. (auth)

52622 ACCURATE WAVELENGTH MEASUREMENT OF THE $1s2p^3P^0-2p^{23}P$ TRANSITION IN ^{4}He I. **Tech, Jack L.; Ward, John F. (National Bureau of Standards, Washington, D. C.). Phys. Rev. Lett.; 27: No. 7, 367-70(16 Aug 1971).**

An accurate spectroscopic measurement yielded 320.2926 ± 0.0010 Å for the wavelength of the $1s2p\ ^3P^0 - 2p^2\ ^3P$ transition in ^{4}He I. Combining this wavelength with the well-known position of the 1s2p term gives an experimental value of 481 301.5 ± 1.2 cm^{-1} for the position of the doubly excited $2p^2\ ^3P$ term relative to the ground $1s^2\ ^1S$. The new measurement is in excellent agreement with Aashamar's theoretical calculation of 481 301.6 cm^{-1} for the energy of the term. (auth)

52623 ZERO-FIELD INTENSITY OSCILLATIONS FOLLOWING IMPLUSIVE EXCITATION OF HYDROGEN. **Burns, Donal J.; Hancock, Walter H. (Univ. of Nebraska, Lincoln). Phys. Rev. Lett.; 27: No. 7, 370-3(16 Aug 1971).**

In a beam-foil experiment, zero-field oscillations of approximately 25% in the intensity of H_β radiation polarized parallel to the beam were observed. An unmodulated decay is observed when a signal proportional to the total intensity is examined. The observations substantiate Macek's theory of coherent decay from fine-structure levels. (auth)

52624 RADIATIVE LIFETIME OF THE 2^1S_0 METASTABLE STATE OF HELIUM. **Van Dyck, Robert S. Jr.; Johnson, Charles E.; Shugart, Howard A. (Univ. of California, Berkeley). Phys. Rev., A; 4: No. 4, 1327-36(Oct 1971).**

A time-of-flight technique was used to measure the radiative lifetime of the $2\ ^1S_0$ state of helium. After passing from a cooled source, helium atoms are excited by a pulsed antiparallel electron beam. The atomic beam then contains not only ground-state helium atoms but also metastable atoms in both the $2\ ^3S_1$ and the $2\ ^1S_0$ states. The metastable atoms are detected at two positions, 1.9 and 6.7 m from the electron gun, by Auger ejection of an electron from a copper target, the first of which is a 60% transmitting mesh. Ground-state helium atoms cannot cause an electron to be ejected and hence are not detected. The time-of-flight distribution for the metastable $2\ ^1S_0$ state is separated from that of the $2\ ^3S_1$ state by illuminating the beam with an rf-discharge helium lamp. The $2\ ^1S_0$ state is quenched by resonant absorption of a 20 581-Å photon, raising the atom to the $2\ ^1P_1$ state, which then decays preferentially to the $^1S_0$ ground state; the $2\ ^3S_1$ state remains unaffected because it is the ground state for the triplet system. The time-of-flight distribution for the $2\ ^1S_0$ atoms is therefore obtained from the difference between the full beam and the quenched beam. A comparison of the number of $2\ ^1S_0$ metastables within a given velocity interval at the two detectors determines the number that decay in flight and yields a value for the two-photon radiative lifetime. The value of the singlet lifetime for both ^{3}He and ^{4}He is 19.7 ± 1.0 msec, agreeing with the theoretical value of 19.5 msec but disagreeing with the value 38 ± 8 msec measured by Pearl using a movable detector. The 1.0-msec error is an estimate of the remaining systematic errors in the experiment. (auth)

52625 AUTO-IONIZATION OF H_2 NEAR THRESHOLD. **Faisal, F. H. M. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., A; 4: No. 4, 1396-1400(Oct 1971).**

It is shown by a model calculation that the internal conversion theory may be used to obtain auto-ionization rates for $\Delta\nu_{if} = 1$ vibrational transitions in H_2, within the right order of magnitude. Thus, the present calculation remedies the apparent inability of the model to predict desirable rates as calculated by previous authors. The results obtained compare fairly well with the experimental estimates of Chupka and Berkowitz, but are closer to the alternative theoretical calculations of Berry and Nielsen for $\Delta\nu_{if} = 1$. It explicitly shows the $1/n^3$ dependence of rates for increasing principal quantum numbers n, and follows the so-called "propensity rule" for vibrational transitions involved. Limitations and possible refinements of the present model are discussed, and the generalization for molecules other than H_2 is indicated. Within the approximation of the model, it provides a simple formula from which rates may be easily estimated. (auth)

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52626 MULTICHANNEL CONFIGURATION-INTERACTION THEORY APPLIED TO THE $(nl^2)^1S$ AUTOIONIZING STATES OF HELIUM. Ramaker, David E. (Univ. of Minnesota, Minneapolis); Schrader, David M. J. Chem. Phys.; 55: No. 1, 471-2(1 Jul 1971).

A generalized Fano configuration-interaction technique is used to investigate the $(nl^2)^1S$ autoionizing states of He. Energies, widths, probability amplitudes, and wave functions are obtained for states with $n = 2$ to 4, $l \leq 2$ and $n = 5$, $l = 0$ with energies in the range 57.96 to 75.51 eV above the ground state. Hartree–Fock wave functions are used as initial approximations to the bound components and an appropriate combination of hydrogenic orbitals is used as initial approximation to the continuum components. Comparison of the calculated results with works of others suggests that the approximations made are reasonable. (A.G.W.)

52627 NEW METHOD FOR CONSTRUCTING THE POTENTIAL CURVES OF DIATOMIC MOLECULES ON THE BASIS OF SPECTROSCOPIC DATA. IV. THE POTENTIAL CURVE OF THE GROUND ELECTRONIC STATE OF THE H_2 MOLECULE. Zhirnov, N. I.; Vasilevskii, A. S. Opt. Spectrosc. (USSR) (Engl. Transl.); 29: No. 4, 352-6(Oct 1970).

Translated from Opt. Spektrosk.; 29: No. 4, 658-65(Oct 1970).

By means of the procedure set forth in previous communications, the potential curve of the ground electronic state of the hydrogen molecule is constructed accurately up to terms of the second order in $\hbar$. It is shown that allowance for the second-order corrections introduces no substantial changes into the potential curve of the zero-order approximation. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 53005, 53120, 53241, 53322, and 53761.

52628 NONEXISTENCE OF A POSITRON–HYDROGEN-ATOM BOUND STATE. Aronson, I. (Hofstra Univ., Hempstead, N. Y.); Kleinman, Chemia J.; Spruch, Larry. Phys. Rev., A; 4: No. 3, 841-6(Sep 1971).

A necessary condition (rather than a sufficient condition, such as that of Rayleigh–Ritz) is needed to even attempt to prove that a given bound state cannot exist. An adiabatic-like method is used to show that a positron (e^+) and a hydrogen atom (H) cannot form a bound state. The separation $\underline{r}$ (but not $\hat{r}$) of the proton (p) and e^+ is fixed; working in a subspace of zero total angular momentum, the lowest energy $E_{el}(\underline{r})$ of the electron in the field of e^+ and p is calculated. An effective one-body $p + e^+$ potential is then defined by $V^{(1)}(\underline{r}) = E_{el}(\underline{r}) + e^2/\underline{r} + e^2/2a_0$. The necessary condition for the existence of a bound state of the true $H + e^+$ system is the existence of a bound state of an artificial $p + e^+$ system with an interaction $V^{(1)}(\underline{r})$. This one-body problem is readily solved, and it is found that it (and therefore the true problem) has no bound state. The proof is not rigorous since $E_{el}(\underline{r})$ is not determined exactly, but the accuracy attained is such as to make the existence of an $H + e^+$ bound state extremely unlikely. A by-product of the calculation is the determination of an improved lower bound on the ground-state energy of H^-. (auth)

52629 OBSERVATION OF A QUADRATIC TERM IN THE HFS PRESSURE SHIFT FOR MUONIUM AND A NEW PRECISE VALUE FOR MUONIUM $\Delta\nu$. Crane, T.; Casperson, D.; Crane, P.; (and others) (Yale Univ., New Haven). Phys. Rev. Lett.; 27: No. 8, 474-6(23 Aug 1971).

New measurements of $\Delta\nu$ for muonium in argon at low pressures and at very weak magnetic fields provide the first observation for muonium of a quadratic term in the hfs pressure shift and lead to a new precise value for the hfs interval in muonium, $\Delta\nu = 4463.311(12)$ MHz. (auth)

Collision Phenomena

Refer also to abstracts 52804 and 52889.

52630 (SC-RR-710474) DIFFERENTIAL AND INTEGRAL CROSS SECTIONS FOR EXCITATION OF THE 2^1S STATE OF HELIUM BY ELECTRON IMPACT. Rice, James K.; Truhlar, Donald G.; Cartwright, David C.; Trajmar, Sandor (Sandia Labs., Albuquerque, N. Mex.). Aug 1971. 114p. Dep. NTIS.

Experimental measurements of the differential scattering cross sections for excitation of helium by electron impact from its ground state to its 2^1S state are given at four incident-electron energies in the range 26 to 55.5 eV for scattering angles between 10° and 70° and at 81.6 eV for scattering angles between 10° and 80°. These differential cross sections are normalized by using previously determined 2^1P cross sections and measured $2^1S/2^1P$ cross-section ratios. These experimental cross sections and cross-section ratios are compared with results predicted by the Born approximation, the polarized Born approximation, and several other first-order approximations in which direct excitation is calculated in the Born approximation and exchange scattering in various Ochkur-like approximations. Calculations based on these approximations are also compared to the data of other experimenters. The effect on the small-angle scattering of several nonadiabatic dipole-polarization potentials is examined. For the 34- to 81.6-eV energy range, it is shown that the inclusion of polarization is necessary for accurate predictions of the angle dependence of the 2^1S cross sections at small angles. The cross sections resulting from the use of analytic self-consistent-field wave functions for both the ground and excited states agree well with those obtained from more accurate correlated wave functions. (auth)

52631 SMALL-ANGLE CHARGE EXCHANGE IN $He^+ + N_2$ COLLISIONS. Fernandez, S. M.; Eriksen, F. J.; Pollack, E. (Univ. of Connecticut, Storrs). Phys. Rev. Lett.; 27: No. 5, 230-2(2 Aug 1971).

Small-angle charge-exchange measurements are made on the $He^+ + N_2$ collision in an energy range from 0.50 to 3.00 keV and in an angular region out to 2.0°. The experimental results directly show that charge exchange plays a major role in the collision. At each energy the probability of charge exchange increases monotonically with increasing angle of scattering and then attains a relatively constant value with further increase in angle. (auth)

52632 IMPACT IONIZATION IN THE PROTON–H-ATOM SYSTEM. IV. IMPROVED VALUES FOR RADIAL TRANSITION MATRIX ELEMENTS. Lebeda, Charles F. (Univ. of Alberta, Edmonton); Thorson, Walter R.; Levy II, Hiram. Phys. Rev., A; 4: No. 3, 900-8(Sep 1971).

Papers I to III of this series describe a theory of direct-impact ionization in slow $H^+-H(1s)$ collisions and the first steps in the calculation of the cross section $\sigma_1(\epsilon)$. It was found that electronic matrix elements for direct-impact ionization are extremely sensitive to the form of the kinematic factor representing radial transport of the electron by a moving heavy particle. In III a heuristic criterion for systematic improvement of the factor and a variational trial form for it were proposed. This proposal was used to recompute radial electronic transition matrix elements for ionization. There is an optimum choice of variational parameters, which greatly reduces the overall size of transition matrix elements. In particular, contributions at large internuclear distances (judged to be spurious in the results of Paper II) are now eliminated, and (except at high electron energies) the contributions to higher partial waves in the electronic continuum are reduced by orders of magnitude. The present results give reasonable confidence that convergence on a "best" first-order transition matrix for the effects of radial motion has been obtained. The existence of a similar optimization problem for the Coriolis-coupling ionization matrix elements is pointed out. (auth)

52633 RADIATIVE CORRECTIONS. II. COMPTON EFFECT. Mork, K. J. (National Bureau of Standards, Washington, D. C.). Phys. Rev., A; 4: No. 3, 917-27(Sep 1971).

The cross section for the double Compton effect is integrated numerically in the laboratory system, and the effect of the radiative tail to the Compton line is discussed. The double Compton effect is also studied in the center-of-mass system for the cases in which the energy of one of the emitted photons is much smaller than the electron rest energy or much smaller than the energy of the incident photon. Expressions for the radiative corrections to the total cross section for Compton scattering are obtained in the high-energy approximation to first order in the fine-structure constant. The total cross section for the double Compton effect is computed by numerical integration. The contribution to the absorption coefficient for high-energy photons from double Compton scattering and Compton scattering with the emission and reabsorption of a virtual photon is obtained. (auth)

52634 ELASTIC AND INELASTIC SCATTERING OF PROTONS BY HYDROGEN ATOMS. Franco, Victor (Brooklyn Coll.); Thomas, Brian K. Phys. Rev., A; 4: No. 3, 945-54(Sep 1971).

The Glauber approximation is applied to elastic scattering of protons by hydrogen atoms and to excitation of the 2s, 2p, 3s, and 3p levels of the hydrogen atom by proton impact. The predicted differential and integrated elastic and excitation cross sections are compared with other calculations and with the available experimental data. A minimum appears in both the 1s–2s and 1s–3s integrated cross sections near 15 keV. The corresponding differential cross sections near 15 keV exhibit a minimum and a maximum at very small scattering angles. The Glauber

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approximation is a considerable improvement over the Born approximation at energies $<\sim 200$ keV and the distortion approximation at energies $<\sim 100$ keV. At energies $>\sim 200$ keV, the present calculated total excitation cross sections are close to the Born approximation. Nevertheless, over most of the angular range the calculated differential cross sections are very different from the Born-approximation values. Above 10 keV the results are in good agreement with the only available experimental data (1s−2p), indicating that above ~ 10 keV the Glauber approximation should yield reasonable estimates for proton−hydrogen-atom collision cross sections. (auth)

52635 X-RAY PRODUCTION BY ALPHA-PARTICLE IMPACT. Garcia, J. D. (Univ. of Arizona, Tucson). Phys. Rev., A; 4: No. 3, 955-7(Sep 1971).

Recent observations of characteristic x rays produced by higher-energy (30 to 80 MeV) α particles are compared to previous measurements and to theoretical calculations based on the impulse approximation. These data are found to be in agreement with theory. The effects of choice of fluorescence yield are discussed. (auth)

52636 INTERPRETATION OF EXPERIMENTAL DIFFERENTIAL ELASTIC SCATTERING CROSS SECTION FOR H^+ + Ne. Bobbio, S. M.; Rich, W. G.; Doverspike, L. D.; Champion, R. L. (Coll. of William and Mary, Williamsburg, Va.). Phys. Rev., A; 4: No. 3, 957-61(Sep 1971).

The result of an experiment on differential scattering of H^+ by Ne at 5.71-eV collision energy is compared to the differential cross section predicted by (a) a JWKB partial-wave calculation based on a potential model, (b) a similar calculation based on the ab initio Peyerimhoff calculated intermolecular potential for the NeH^+ system, and (c) a new and more efficient calculational scheme developed by Remler involving Regge poles. The agreement of the Peyerimhoff prediction, (b), with the experimental data is very good. Differences between the Peyerimhoff potential and the final values of the parameters retrieved from the iterative calculation in (a), as well as implicit ambiguities of (a) in reproducing the features of a low-resolution experiment, are discussed in terms of semiclassical theory and the Remler−Regge method. (auth)

52637 GENERALIZED IMPACT-PARAMETER METHOD FOR LOW-ENERGY MOLECULAR COLLISIONS. Corrigall, B.; Kuppers, B.; Wallace, R. (Univ. of Manitoba, Winnipeg). Phys. Rev., A; 4: No. 3, 977-84(Sep 1971).

A generalized impact-parameter method (not based upon perturbation theory), which is capable of describing the evolution of a collision system throughout the entire interaction region, is developed. The method is then applied to the collision of a proton and a hydrogen atom at low (chemical) energies. The results obtained suggest that static calculations such as those using molecular potential-energy surfaces do not represent a very real picture of a dynamic process like a collision. Furthermore, the model does not assume linear trajectories for the atoms. This is shown from the calculations to be of importance in such low-energy collisions, the trajectories being far from linear. The model is capable of generalization to collisions in which more than two atoms are involved, such as the three-body reaction A + BC → AB + C. (auth)

52638 DELAYED-COINCIDENCE STUDY OF O^+−Xe COLLISIONS AT 50 TO 210 keV. Bingham, Felton W.; Rice, James K. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., A; 4: No. 3, 996-1002(Sep 1971).

Delayed-coincidence techniques have provided measurements of $\overline{Q}(r_0)$ for O^+−Xe collisions in the energy range 50 to 210 keV; here r_0 represents the distance of closest approach of the colliding particles, and $\overline{Q}$ is the average energy transferred to inelastic processes. At fixed r_0 the $\overline{Q}$ values increase with bombarding energy. The $\overline{Q}$ values generally increase as r_0 decreases although they remain constant over some regions of r_0 within the range (0.05 to 0.25 Å) covered by the experiment. The r_0 regions in which $\overline{Q}$ increases appear to be correlated with regions in which the differential cross sections for beam-particle scattering fail to vary according to the predictions of the exponentially screened Coulomb potential. Simple interpretations of the data attribute these results to the effects of electronic shell interpenetrations during the collisions. Supplementing the $\overline{Q}$ and cross-section data are determinations of average ionic charge states after collision and calculations of inelastic energy-loss cross sections deduced from the $\overline{Q}$ results. (auth)

52639 RELATIVISTIC TREATMENT OF THE EXCITATION OF CHARACTERISTIC L X RAYS BY THE IMPACT OF HEAVY CHARGED PARTICLES. Choi, Byung-ho (Univ. of North Carolina, Chapel Hill). Phys. Rev., A; 4: No. 3, 1002-08(Sep 1971).

The cross sections for L electron ionization by incident heavy, but slow, charged particles are evaluated. Incident particles are described in the plane-wave Born approximation, and relativistic wave functions are used for the atomic electrons. Numerical results are given for holmium and mercury and compared with experimental data for holmium. The results are discussed. (auth)

52640 LOW-ENERGY ELECTRON SCATTERING IN THE RANDOM-PHASE APPROXIMATION. Schneider, Barry; Krugler, Joel I. (GTE Labs., Inc., Bayside, N. Y.). Phys. Rev., A; 4: No. 3, 1008-16(Sep 1971).

A general formalism for the computation of low-energy inelastic and elastic electron scattering cross sections within the context of the particle−hole Bethe−Salpeter equation is presented and shown to reduce to the random-phase approximation (RPA) in lowest order. The theory is then applied to triplet elastic electron−He^+ scattering. A short discussion of the differences between the RPA for scattering processes and for low-lying bound states is given, and the numerical methods used to solve the equations are considered in some detail in an appendix. (auth)

52641 CLOSE-COUPLING STUDIES OF ROTATIONAL EXCITATION IN H−H_2 COLLISIONS. Hayes, Edward F. (Rice Univ., Houston, Texas); Wells, Charles A.; Kouri, Donald J. Phys. Rev., A; 4: No. 3, 1017-25(Sep 1971).

Close-coupling calculations are reported for low-energy H−H_2 collisions. These results are compared with Tang's distorted-wave calculations of the differential and total cross sections for the $j = 0$ to $j = 2$ rotational transition. The close-coupling results for the total cross section are found to agree quantitatively with the distorted-wave results. Furthermore, the relative transition probabilities for various partial waves determined by Tang agree qualitatively with the close-coupling results reported here. The strong forward peaking in the cross section $\sigma(\theta)$ reported by Tang is also found in the present study. However, there appear to be significant differences in the magnitudes and positions of oscillations in the differential cross sections as determined by the close-coupling and distorted-wave methods. Finally, close-coupling results for the $j = 0$ elastic scattering differential cross section are presented and discussed briefly. (auth)

52642 LOW-ENERGY ELECTRON EJECTION OF ATOMS IN COLLISIONS WITH RELATIVISTIC ELECTRONS. Das, J. N. (Nabadwip Vidyasagar Coll., Nadia, India). Phys. Rev., A; 4: No. 3, 1025-30(Sep 1971).

Low-energy electron-ejection cross sections of atoms in collisions with relativistic electrons were calculated. The calculations are similar to those of Weber et al. In the approximate integration of the differential cross section over certain angles, Weber et al., considered Z small and obtained a $(\alpha Z)^4$-dependent result. A different type of approximation, valid for $Z \gg 1$, was followed in this work, and the explicit $(\alpha Z)^5$-dependent result was obtained. The result shows a much stronger dominance of the distribution of ejected electrons over the "Parzen distribution" in the low-energy region than the results of Weber et al., when applied to atoms with $Z \gg 1$. (auth)

52643 NONADIABATIC EFFECTS IN SLOW ATOMIC COLLISIONS. I. He^+ + He. Rosenthal, H. (Columbia Univ., New York). Phys. Rev., A; 4: No. 3, 1030-42(Sep 1971).

In the collision $He^+ + He \rightarrow He^+ + He^*$, excitation at low incident-ion energies ($\lesssim 1$ keV) proceeds via a pseudocrossing of the elastic $^2\Sigma_g$ diabatic potential with excited-state $^2\Sigma_g$ potentials. As previously reported, this excitation mechanism fails to explain diverse experimental data concerning total excitation cross sections. A new physical mechanism is hypothesized, its existence is verified, and it is shown to provide good qualitative and semiquantitative interpretation of the observations. Nonadiabatic couplings among some excited states occur at pseudocrossings of the respective inelastic-channel molecular potentials at large internuclear separations, resulting in coherent phase interference in the inelastic-scattering amplitudes. A linear-combination-of-atomic-orbitals (LCAO) calculation of 18 excited-state $^2\Sigma_g$ potentials of the intermediate $(He_2^+)^*$ system verifies the presence of these outer pseudocrossings. Such a mechanism is shown to be likely in many ion−atom collisions. (auth)

52644 STUDIES OF THE POTENTIAL-CURVE CROSSING PROBLEM. I. ANALYSIS OF STUECKELBERG'S METHOD. Thorson, Walter R. (Univ. of Alberta, Edmonton); Delos, John B.; Boorstein, Seth A. Phys. Rev., A; 4: No. 3, 1052-66(Sep 1971).

A detailed critical analysis is made of Stueckelberg's treatment of inelastic transitions at a crossing of two potential curves. Using an asymptotic method analogous to the WKB approximation, Stueckelberg obtained the well-known Landau−Zener−Stueckelberg (LZS) formula for the inelastic transition probability. His

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method involved the determination of "connection formulas" linking amplitudes associated with his asymptotic approximants on either side of the crossing-point region. Here it is shown that (a) Stueckelberg's asymptotic approximants are just the WKB approximants for elastic scattering on the adiabatic (noncrossing) potential curves; (b) Stueckelberg's method for obtaining the connection formulas can be put on a rigorous footing, including sufficient conditions for its validity, using the classical trajectory equations derivable from a general semiclassical theory of inelastic atomic collisions; (c) there is an undetermined phase in the S matrix, which Stueckelberg incorrectly assumed to be zero and which has the value $\frac{1}{4}\pi$ in the distorted-wave approximation; (d) Stueckelberg's derivation is not valid whenever the inelastic transition probability is small, either in the rapid-passage (diabatic) case or the near-adiabatic limit; (e) for realistic model parameters, the conditions needed for Stueckelberg's derivation to be valid are almost never satisfied. Since the LZS formula is known from numerical computations to be valid under some conditions when the Stueckelberg derivation is not valid, it is concluded that analysis via connection-formula methods is not a useful technique for treating the crossing problem. In an appendix an analytical result for the Stokes's constants determining the Stueckelberg connection formulas is derived. The result is an absolutely convergent, infinite series whose numerical evaluation would yield exactly the unknown phase associated with the LZS formula. (auth)

52645 DYNAMIC COUPLING PHENOMENA IN MOLECULAR EXCITED STATES. III. ASSOCIATIVE IONIZATION AND DISSOCIATIVE RECOMBINATION IN H_2. Nielsen, Svend Erik (Univ. of Copenhagen); Berry, R. Stephen. Phys. Rev., A; 4: No. 3, 865-85(Sep 1971).

A detailed calculation based on a perturbed stationary-state description is presented for associative ionization of hydrogen atoms. Specific rate constants k_{AI} (v, K, T) are evaluated for the set of electronic states correlating with H(n = 1) + H(n = 3) for associative ionization into vibrational (v = 0 to 8) and rotational (K = 0 to 21) states of $H_2^+(X^2\Sigma_g^+)$ at T = 300°K and at T = 600°K. Cross sections Q_{AI}(v, K, E) are given for the most significant electronic state, the (1sσ, 4sσ) united atom configuration, and, by microscopic reversibility, cross sections for the reverse reaction, dissociative recombination, are obtained. Cross sections for associative ionization at thermal energies, Q_{AI}(v, K, 10^{-3} a.u.), are at most of a magnitude about 10^{-18} cm^2. Corresponding specific rate constants, k_{AI}(v, K, 300°K), fall in the range 10^{-14} to 10^{-13} cm^3/sec and display a temperature dependence $k_{AI}(T) \propto T^{-0.33}$. Dissociative recombination cross sections, Q_{DR}(v, K, 10^{-3} a.u.), are obtained for the v = 4 to 8 vibrational states, with magnitudes about 10^{-16} cm^2. The resulting specific rate constants, k_{DR}(v, K, 300°K), are at most 10^{-10} cm^3/sec and display a temperature dependence $k_{DR}(T_e) \propto T_e^{-1/2}$ for $T_e \lesssim 80$°K, $k_{DR}(T_e) \propto T_e^{-0.75}$ for $T_e \approx 300$°K, and a still larger-power decrease for increasing T_e at $T_e > 300$°K. (auth)

52646 INELASTIC COLLISIONS OF FAST CHARGED PARTICLES WITH ATOMS AND MOLECULES: THE BETHE THEORY REVISITED. Inokuti, Mitio (Univ. of Colorado, Boulder. National Bureau of Standards, Boulder, Colo.). Rev. Mod. Phys.; 43: No. 3, 297-347(Jul 1971).

The current understanding is summarized from a unified point of view, which Bethe initiated four decades ago and which enables one to put a variety of theoretical and experimental data into a coherent picture. Properties of the generalized oscillator strength, which plays the central role in the theory, are treated in detail. The integrated cross section for inelastic scattering and related quantities at the high-velocity limit also are discussed. The theory provides a series of criteria for testing the compatibility of cross-section data and atomic (or molecular) properties that may be obtained from theory or independent experiments. (362 references) (auth)

52647 TRANSLATION FACTOR IN BASIS FUNCTIONS USED IN PERTURBED STATIONARY-STATE APPROXIMATION AND CAPTURE IN H^+–H(1s) COLLISIONS. Bates, D. R.; Sprevak, D. (Queen's Univ., Belfast). J. Phys., B (London); 4: No. 6, L47-51(Jun 1971).

It is argued that the translation factor in the basis functions of the perturbed-stationary-state approximation must, in the separated atoms limit, involve v · r rather than $\dot{R}$r where v is the relative velocity of the nuclei, r is the position vector of the active electron, and R is the distance between the nuclei. The adoption of the incorrect translation factor leads to the appearance of spurious terms, increasing indefinitely with R, in the transition matrix elements. This has an insignificant effect on capture in slow H^+–H(1s) collisions. (auth) (UK)

52648 FORWARD ELASTIC SCATTERING OF ELECTRONS BY HELIUM. Holt, A. R.; Hunt, J.; Moiseiwitsch, B. L. (Univ. of Essex, Eng.). J. Phys., B (London); 4: No. 6, L41-4(Jun 1971).

It is shown that the differential cross section for the elastic scattering of electrons by helium atoms in the forward direction, calculated using the third-order approximation, is in satisfactory accordance with the values obtained by Branden and McDowell (1970) employing a dispersion relation and with their extrapolations of experimental data to zero angle. (auth) (UK)

52649 ELASTIC SCATTERING OF ELECTRONS BY LITHIUM ATOMS USING MODIFIED GLAUBER APPROXIMATION. Mathur, K. C.; Tripathi, A. N.; Joshi, S. K. (Univ. of Roorkee, India). J. Phys., B (London); 4: No. 6, L39-41(Jun 1971).

The Glauber approximation was used to study the elastic scattering of electrons by lithium atoms. The effect of core electrons was ignored by adopting a frozen-core approximation. The total cross section for elastic scattering is compared with other theoretical calculations and with the experimental data. (auth) (UK)

52650 INELASTIC PROTON–HYDROGEN SCATTERING BY GLAUBER APPROXIMATION. Ghosh, A. S.; Sil, N. C. (Indian Association for the Cultivation of Science, Calcutta). J. Phys., B (London); 4: No. 6, 836-40(Jun 1971).

The Glauber approximation was applied to the 1s–2s and the 1s–2p excitations of hydrogen atoms by proton impact. The total cross sections for the processes were calculated for incident proton energies ranging from 1 keV to 1 MeV. These were compared with the corresponding results of other theoretical workers. Comparison was also made with the available experimental results. At incident-energy values of 20 and 30 keV, the results for the total cross sections for the 1s–2p excitation coincide with the experimental values. (auth) (UK)

52651 FORMATION OF METASTABLE HELIUM ATOMS BY ELECTRON CAPTURE DURING THE PASSAGE OF FAST He^+ IONS THROUGH GASES. Gilbody, H. B.; Dunn, K. F.; Browning, R.; Latimer, C. J. (Queen's Univ., Belfast). J. Phys., B (London); 4: No. 6, 800-13(Jun 1971).

A beam-attenuation technique was used to investigate the formation of metastable helium atoms by electron capture of 10- to 200-keV He^+ ions in hydrogen, helium, neon, argon, krypton, and nitrogen. The fractions of metastable atoms formed in both thin and thick targets were determined and used to obtain separate cross sections for the formation of ground-state and metastable atoms. The equilibration of the metastable component of the beam in thick targets was also described quantitatively in terms of the relevant charge-changing collisions. (auth) (UK)

52652 ATOMIC COLLISION THEORY. Bransden, B. H. Lecture Notes and Supplements in Physics. New York; W. A. Benjamin, Inc. (1970). 467p.

The first four chapters of this text form a self-contained account of nonrelativistic quantum scattering theory as related to atomic processes. Included are such topics as the Born approximation, the optical theorem, and analytic properties of scattering amplitudes. Sections are devoted to generalized effective-range series and to the Faddeev equations for three-particle scattering. The second half of the book applies the theory to a variety of problems in atomic physics, including electron–atom scattering, autoionization and resonances in electron–atom collisions, charge exchange between atoms and ions, and electron scattering by molecules. The present state of the theory is compared with recent experimental results. (A.G.W.)

52653 NEW VALUE FOR THE METASTABILITY EXCHANGE CROSS SECTION IN HELIUM. Dupont-Roc, Jacques; Leduc, Michele; Laloe, Franck (Ecole Normale Superieure, Paris). Phys. Rev. Lett.; 27: No. 8, 467-70(23 Aug 1971).

The angular aspect of metastability exchange collisions between ground-state and 2^3S_1 metastable ^{3}He atoms was investigated theoretically and experimentally. Coupling between the orientations of the two 2^3S_1 hyperfine levels and partial coherence survival after a collision are shown to be important. A different interpretation of previous experiments is proposed, and a new value of the metastability exchange cross section, $\sigma = (7.6 \pm 0.4) \times 10^{-16}$ cm^2, is suggested. The case of ^{3}He–^{4}He mixtures is also studied. (auth)

52654 QUENCHING OF METASTABLE HYDROGEN BY HELIUM. Kass, R. S.; Williams, W. L. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett.; 27: No. 8, 473-4(23 Aug 1971).

Measurements of collisional quenching of metastable hydrogen by helium in the thermal region ($v \simeq 5 \times 10^{-3}$ a.u.) have been made. The resulting cross section $\sigma_Q \simeq 8 \times 10^{-15}$ cm^2 per atom is 20 to 25% larger than the theoretical results obtained by Byron and Gersten using a pseudopotential method. (auth)

52655 DIFFERENTIAL CROSS SECTIONS AND PARAMETERS FOR KINETIC SCATTERING OF ATOMS BY ATOMS AT KILOVOLT ENERGIES. Nikulin, V. K. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 1, 21-7(Jul 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 1, 33-40(Jan 1971).

The use of various interatomic potentials (the Bohr shielded Coulomb potential and the Firsov potential and its modifications) for describing the scattering of atoms within the framework of classical mechanics is discussed. These potentials are compared with each other and with a potential calculated by the author on the basis of a statistical model but with the use of data on the electron density in the atomic shells obtained from quantum mechanical calculations. A universal modified Firsov potential is used to calculate the distances of closest approach, the impact parameters, and the differential cross sections as functions of the scattering angle in the center-of-mass system for 14 values of the parameters B/A ($B = Z_1Z_2e^2/E$; Z_1 and Z_2 are the charges of the atomic nuclei, E is the energy of the relative motion, and A is the characteristic shielding length). (auth)

52656 COLLISIONAL QUENCHING OF METASTABLE HYDROGEN BY GROUND-STATE HYDROGEN ATOMS. Flannery, M. R. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Physica; 53: No. 1, 28-31(17 May 1971).

The quenching of the 2s metastable state of hydrogen by hydrogen-atom impact appears to be controlled, at low incident energies, by a single 2s–2p transition, with subsequent decay to the 1s state rather than by direct de-excitation to the ground state. With further increase of impact energy, excitations of both target and projectile atoms to p states, which spontaneously emit to the ground state, begin to dominate the quenching process. (auth)

52657 ABSOLUTE CROSS SECTIONS FOR EXCITATION OF HELIUM BY ELECTRONS (20 TO 2000 eV) AND THE POLARIZATION OF THE EMITTED RADIATION. Van Raan, A. F. J.; De Jongh, J. P.; Van Eck, J.; Heideman, H. G. M. (Rijksuniversiteit, Utrecht). Physica; 53: No. 1, 45-59(17 May 1971).

Absolute cross sections for excitation by electrons from the ground state of helium to 4^1S, 5^1S, 6^1S, 3^1P, 4^1D, 5^1D, 6^1D, 4^3S, and 3^3P states of helium were determined by observing the resulting light emission. The energy region covered extends from 20 to 2000 eV. Two devices were used, one for electron energies from threshold up to 100 eV and another for higher impact energies. All line-intensity measurements were corrected for the polarization of the radiation, the polarizing effect of the monochromator and space-charge effects. In the evaluation of the excitation cross sections cascading effects were taken into account. The energy dependence of the 1^1S-3^1P cross section is in very good agreement with theoretical calculations above about 200 eV. The experimental values for the n^1S and 3^1P levels are in the asymptotic high-energy region about 10% larger than the theoretical ones according to the Born approximation. The energy dependences of the n^1S and 3^1P cross sections are in good agreement with the results of Moustafa Moussa et al. Our n^1D cross sections are, although 14 to 35% larger than the theoretical values, closer to the Born values than previous experimental results. In a plot of cross section times electron energy against the logarithm of the electron energy the n^1D curves exhibit a maximum. This effect becomes less pronounced for higher principal quantum numbers. The energy dependences of the 4^3S and 3^3P cross sections do not agree with the E_{el}^{-3} law as predicted by Ochkur. For energies larger than 100 eV a decrease proportional to $E_{el}^{-2.0}$ for the 4^3S level and to $E_{el}^{-2.4}$ for the 3^3P level is found. The polarization results for the 3^1P-2^1S light emission show very good agreement with the Born theory. The energy dependence of the polarization degree of the radiation of n^1D-2^1P transitions is over a large energy range (150 to 1000 eV) in agreement with theoretical calculations; however, the magnitude of the polarization degree differs with theory, which is also the case in previous experiments of other investigators. (auth)

52658 COLLISIONAL QUENCHING OF METASTABLE HYDROGEN ATOMS. Slocomb, C. A.; Miller, W. H.; Schaefer III, H. F. (Univ. of California, Berkeley). J. Chem. Phys.; 55: No. 2, 926-32(15 Jul 1971).

Quenching of metastable hydrogen atoms by low-energy collisions with atoms and molecules is considered, the actual process being $H(2s) + X \rightarrow H(2p) + X$. The Born approximation, with long-range multipole–multipole interactions, is used to describe collisions of H(2s) with molecules, and simple formulas for the cross section result. Collisions with spherically symmetric species (i.e., rare gas atoms) are treated in the adiabatic approximation, and the process is seen to be formally identical to symmetric charge transfer. Numerical results for collisional quenching by helium, based on accurately computed potential curves, are presented. (auth)

52659 SEMICLASSICAL TRANSITION PROBABILITIES FOR ROTATIONALLY INELASTIC SCATTERING. Cross, R. J. Jr. (Yale Univ., New Haven). J. Chem. Phys.; 55: No. 2, 510-8 (15 Jul 1971).

Degeneracy-averaged partial cross sections for rotationally inelastic scattering are calculated using semiclassical methods. Assuming a classical linear trajectory, simple expressions are derived for the sudden limit, the classical limit, and first-order limit. A single uniform approximation is obtained, which converges to all three limits. The partial inelastic cross section $Q_{j'\leftarrow j}$ is given by $D\Sigma C^2(j\lambda j';\ 000)\ A_\lambda(d)$, where D and d are reduced parameters, C is the Clebsch–Gordan coefficient, and A_λ is a set of integrals depending on the potential form; the A_λ's are calculated for the ion–dipole and anisotropic van der Waals potentials and in the sudden limit for the dipole–dipole potential. (auth)

52660 TRAJECTORY SURFACE HOPPING APPROACH TO NONADIABATIC MOLECULAR COLLISIONS: THE REACTION OF H^+ WITH D_2. Tully, John C. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Preston, Richard K. J. Chem. Phys.; 55: No. 2, 562-72(15 Jul 1971).

An extension of the classical trajectory approach is proposed that may be useful in treating many types of nonadiabatic molecular collisions. Nuclei are assumed to move classically on a single potential-energy surface until an avoided surface crossing or other region of large nonadiabatic coupling is reached. At such points the trajectory is split into two branches, each of which follows a different potential surface. The validity of this model as applied to the HD_2^+ system is assessed by numerical integration of the appropriate semiclassical equations. A 3D "trajectory surface hopping" treatment of the reaction of H^+ with D_2 at a collision energy of 4 eV is reported. The excellent agreement with experiment is an encouraging indication of the potential usefulness of this approach. (auth)

52661 EXCITATION OF PARITY-FORBIDDEN TRANSITIONS IN H_2 BY ENERGETIC ELECTRONS. Ford, Lewis; Browne, J. C. (Univ. of Texas, Austin). J. Chem. Phys.; 55: No. 3, 1053-5 (1 Aug 1971).

The cross sections for energetic electron excitation of the parity-forbidden $X\ {}^1\Sigma_g^+ \rightarrow E, F\ {}^1\Sigma_g^+$ transitions are calculated in the Born approximation. The intensities for these forbidden transitions are predicted to be comparable to the intensities of the allowed $X\ {}^1\Sigma_g^+ \rightarrow C\ {}^1\Pi_u$ and $X\ {}^1\Sigma_g^+ \rightarrow B\ {}^1\Sigma_u^+$ transitions for scattering angles as small as 0.75° for 34-keV electrons. (auth)

52662 THEORY OF ATOM–DIATOM COLLISIONS. IV. ON INTEGRAL-EQUATION FORMALISMS FOR RESONANCE LEVEL WIDTHS AND POSITIONS. Sams, W. Neal; Kouri, Donald J. (Univ. of Houston, Tex.). J. Chem. Phys.; 55: No. 3, 1248-56(1 Aug 1971).

Integral-equation approaches to the level width and position of compound-state resonances are examined. A new description of the resonance state in terms of the eigenvectors and eigenvalues of Hermitian operator $QHQ + QHP[\mathscr{P}/(E - PHP)]\ PHQ$ is explored in some detail. It is shown that one may utilize the formalism of Sams and Kouri to avoid expansions of the nonlocal effective potential in terms of approximate compound-state eigenfunctions. The procedure developed thus avoids difficulties such as neglect of the continuum of the closed-channel projected Hamiltonian (or effective Hamiltonian) and should permit the evaluation of accurate level widths and positions by a single solution of a set of close-coupled inhomogeneous integral equations. These coupled equations are similar in nature to the original coupled open- and closed-channel scattering equations except that the inhomogeneity in the new equations is exactly that appropriate for describing the bound complex rather than an unbound scattering state. Finally, the integral-equation technique may be used to study any of the various alternative descriptions of the compound-state resonance. (auth)

52663 CROSS SECTION FOR DOUBLE IONIZATION BY ELECTRON IMPACT: Li^+, Na^+, K^+. Tripathi, D. N.; Rai, D. K. (Banaras Hindu Univ., India). J. Chem. Phys.; 55: No. 3, 1268-71(1 Aug 1971).

The cross sections for double ionization by electron impact on Li^+, Na^+, and K^+ ions were calculated using Grysinski's semiclassical formula. Good agreement is obtained between calculated results and experiment in the case of Li^+, and it is expected that the results for Na^+ and K^+ would also be reliable. The ratio σ_+/σ_{++} (single ionization/double ionization) is also calculated and compared with the experimental results and theoretical predictions. (auth)

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52664 DIRECT NUMERICAL SOLUTION TO THE CHARGE-EXCHANGE PROBLEM. I. **Leventhal, Lance; Rotenberg, Manuel** (Univ. of California, San Diego, La Jolla). J. Chem. Phys.; 55: No. 3, 1272-6(1 Aug 1971).

In light of the capabilities of modern digital computers the question of direct numerical solution of the time-dependent Schrödinger equation is raised. It is found that solutions are feasible for the one-electron charge-transfer problem. Detailed algorithms are given, and a discussion of the errors committed when reducing quantum mechanical operators to numerical operators is presented. Examples of charge transfer are given in the form of contour plots for collisions in one and two dimensions. (auth)

52665 PRODUCTION OF LIGHT BY COLLISIONS OF 2.5- TO 490-eV He^+ WITH N_2: N I, N_2^+ SECOND NEGATIVE, AND UNRESOLVED EMISSIONS BETWEEN 1200 AND 3200 A. **Holland, Redus F.; Maier II, William B.** (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys.; 55: No. 3, 1299-1314(1 Aug 1971).

The production of light in collisions between He^+ and N_2 was studied at primary ion energies, E, between 2.5 and 490 eV. Strong emissions are present between 1200 and 3200 Å, and spectra were obtained for spectral resolutions between 1.5 and 16 Å. N I emissions, N_2^+ second negative (2N) emissions, and strong, unresolved emissions were found. The total cross section for producing the emission between 1200 and 3200 Å is of the order of 10^{-16} cm². For $E \lesssim 40$ eV, the cross section for producing the unresolved emissions is greater than the cross section for producing the N_2^+ (2N) emissions. The cross section for production of the N I emissions decreases with decreasing E and vanishes near the threshold energies expected for N I emission produced by $He^+ + N_2 \rightarrow N^+ + N + He$. With decreasing E, total cross sections for the N_2^+ (2N) and unresolved emissions increase. Apparent populations of the vibrational levels of the N_2^+ (2N) parent state depend differently on E; in particular, for E = 490 eV the $v' = 1$ and 2 levels are the most highly populated, and for E = 4.5 eV the $v' = 3$ and 4 levels are the most highly populated. The electronic transition moment of the $C\,^2\Sigma_u^+ \rightarrow X\,^2\Sigma_g^+$ transitions, which produce the N_2^+ (2N) emissions, varies considerably with the wavelength of the emitted light. (auth)

52666 PROTON–HYDROGEN COLLISIONS: MOLECULAR TREATMENT OF THE H(2p) EXCITATION. **Rosenthal, H.** (Yale Univ., New Haven). Phys. Rev. Lett.; 27: No. 10, 635-8(6 Sep 1971).

The molecular treatment of the reaction $p + H(1s) \rightarrow p + H(2p)$ was reexamined. Exact H_2^+ wave functions and dynamic coupling elements were calculated and used throughout. Two- and four-state calculations were carried out in the range 0.1 to 16 keV and compared with previous theoretical and experimental findings. The results support the validity of the molecular approach at higher velocities than previously considered. A new basis set, rather than translational factors, eliminates spurious asymptotic radial coupling inherent in the Born–Oppenheimer basis. (auth)

52667 ASSOCIATIVE IONIZATION IN SLOW COLLISIONS BETWEEN ATOMS. I. **Nakamura, Hiroki** (Tokyo Univ.). J. Phys. Soc. Jap.; 31: No. 2, 574-83(Aug 1971).

Associative ionization through slow collisions of an atom with a metastable atom is investigated theoretically, in which the excitation energy of an excited atom is larger than the ionization potential of the other atom. The process is dealt with by the local-complex-potential method, since in this case the initial discrete electronic state is a resonance state because of the coupling with a degenerate continuum. Cross-section formulas are obtained for a molecular-ion formation with specified rotational and vibrational quantum numbers (j, v) and a total associative ionization. As a demonstration the method is applied to the system $He^*(2^3S, 2^1S) + H$. Population inversion with respect to vibrational levels is expected to occur fairly effectively in these processes. (auth)

52668 EFFECTIVE CROSS SECTIONS FOR THE FORMATION OF EXCITED CADMIUM IONS DURING IONIZATION OF CADMIUM ATOMS BY ELECTRON IMPACT. **Varshavskii, S. P.; Mityureva, A. A.; Penkin, N. P.** Opt. Spectrosc. (USSR) (Engl. Transl.); 29: No. 4, 341-3(Oct 1970).

Translated from Opt. Spektrosk.; 29: No. 4, 637-40(Oct 1970).

Absolute values of the effective cross sections for the formation of excited cadmium ions during ionization of cadmium atoms by electron impact and the excitation functions of the spectral lines and the S, P, and D levels of the cadmium ion, which refer to the ordinary and the Beutler systems of levels, are determined. The excitation cross sections of the lower Beutler levels ^2D are almost twice the cross sections of the resonance levels ^2P in the ordinary system; the order of magnitude of both cross sections is 10^{-17} cm². A strong cascade population of the $6^2P_{1/2,3/2}$ levels from the Beutler system, amounting to 70% of the total population, has been observed. (auth)

52669 TRANSITION TO THE SEMI-CLASSICAL LIMIT IN PROBLEMS OF INELASTIC COLLISIONS OF HEAVY CHARGED PARTICLES. **Vinogradov, A. V.; Urnov, A. M.** Opt. Spectrosc. (USSR) (Engl. Transl.); 29: No. 4, 348-9(Oct 1970).

Translated from Opt. Spektrosk.; 29: No. 4, 649-52(Oct 1970).

The relationship between the quasi-classical and the quantum-mechanical approaches to the problems of inelastic collisions of heavy particles in the presence of a Coulomb field is examined. It is shown that the first approximation of quasi-classical perturbation theory is equivalent to the Born–Coulomb approximation for the scattering amplitude. (auth)

52670 EXCITATION OF CARBON ATOMS AND CARBON-LIKE IONS BY ELECTRON IMPACT. **Poshyunaite, N. P.; Lyash, A. V.; Bolotin, A. B.** Opt. Spectrosc. (USSR) (Engl. Transl.); 29: No. 4, 424-6(Oct 1970).

Translated from Opt. Spektrosk.; 29: No. 4, 799-801(Oct 1970).

The effective cross sections for excitation of C by electron impact for the transitions $1s^22s^22p^2 \rightarrow 1s^22s2p^3$, $1s^22s^2sp^2 \rightarrow 1s^22s^22p3s$, and $1s^22s^22p^2 \rightarrow 1s^22s^22p3p$ and of the carbon-like ions N^+ and O^{2+} for the $1s^22s^22p^2 \rightarrow 1s^22s2p^3$ transition were calculated in the Born, Born–Ochkur, and Vainshtein–Presnyakov–Sobelman (VPS) approximations with exchange and polarization included. It is concluded that the total effective cross section is very sensitive to the form of the wave function and that it decreases as Z increases from 6 to 8. The cross section decreased when exchange was included in the first Born approximation. For calculations based on the VPS approximation, the largest value was obtained when the effective charge was taken into account; including exchange reduced the value, and the smallest values were obtained when exchange and effective charge were both neglected. (A.G.W.)

52671 ENERGY DISTRIBUTION OF FINAL PRODUCTS IN MOLECULAR COLLISIONS. **Levine, R. D.** (Hebrew Univ., Jerusalem); **Wolf, F. A.; Maus, J. A.** Chem. Phys. Lett.; 10: No. 1, 2-6(1 Jul 1971).

An optical model analysis suggests that the cross section (for a given transition) is an increasing function of the final (kinetic) energy. The energy distribution is derived on the basis of the kinematical restrictions in the final channel. As an example, a statistical approximation for the reaction $H^- + O_2$ is considered. (auth)

52672 MOLECULAR RAMSAUER–TOWNSEND EFFECT IN VERY LOW ENERGY ^{4}He–^{4}He SCATTERING. **Miller, W. H.** (Univ. of California, Berkeley). Chem. Phys. Lett.; 10: No. 1, 7-9(1 Jul 1971).

It is shown that a Ramsauer–Townsend effect is possible in very-low-energy (≈2°K) collisions of ^{4}He–^{4}He, i.e., a deep minimum in the total elastic scattering cross section occurs at this collision energy. It is seen that no such minimum is possible for the other isotopic variants, ^{3}He–^{3}He and ^{3}He–^{4}He. (auth)

52673 REACTION OF HYDROGEN ATOMIC IONS WITH HYDROGEN MOLECULES: EXPERIMENT, AB INITIO THEORY, AND A CONCEPTUAL MODEL. **Krenos, J.** (Yale Univ., New Haven); **Preston, R.; Wolfgang, R.; Tully, J.** Chem. Phys. Lett.; 10: No. 1, 17-21(1 Jul 1971).

Ab initio calculations on trajectories and nonadiabatic transitions in reactions between H^+ and D_2 are compared with experimental data on cross sections and on angular and velocity distributions. Good agreement indicates the essential validity of the theoretical model. The latter provides interesting conceptual insights into basic kinetics. (auth)

52674 SCATTERING OF SLOW ELECTRONS BY NEON AND ARGON. **Garbaty, E. A.; LaBahn, R. W.** (Louisiana State Univ., Baton Rouge). Phys. Rev., A; 4: No. 4, 1425-31(Oct 1971).

Total elastic scattering cross sections were computed for the scattering of electrons by neutral neon and argon in the energy range 0 to 1 Ry. These results were obtained by the polarized-orbital method wherein a polarization potential accounts for the distortion of the atomic electron distribution by the scattering electron. The polarization potentials are determined using perturbed orbitals obtained by the Sternheimer and Hartree–Fock–Slater (HFS) approximations. Dipole polarizabilities are also calculated. The results are used to evaluate total scattering cross sections by the two approximations and evaluate their capabilities by comparison with experimental data. The HFS-based approximation works very well for neon giving substantially improved cross sections over earlier Sternheimer-based calculations by Thompson. However, little improvement is obtained in either case for argon. (auth)

52675 ELECTRON CAPTURE AND LOSS IN COLLISIONS OF HEAVY IONS WITH ATOMIC OXYGEN. **Lo, H. H.; Kurzweg, L.; Brackman, R. T.; Fite, W. L. (Univ. of Pittsburgh). Phys. Rev., A; 4: No. 4, 1462-76(Oct 1971).**

Electron-capture and electron-loss cross sections for various gaseous (N^+, O^+, Ar^+, Kr^+, and Xe^+) and metallic (Al^+, K^+, Fe^+, Ba^+, and Ba^{++}) ions in collisions with atomic oxygen were measured in the energy range 30 keV to 2 MeV. Beam-in-static-gas techniques were employed. Ions formed by an electron-impact ion source were mass-selected by a rf quadrupole mass filter and were accelerated by a Van de Graaff accelerator into a fast well-collimated ion beam. This ion beam was then steered through an atomic-oxygen target chamber developed to provide a collision region containing thermally dissociated oxygen atoms in the ground state. The charge states of the emerging fast-ion beam were measured and this information along with knowledge of the atomic-oxygen-target thickness within the target chamber was used to deduce the electron-capture and electron-loss cross sections of the particular fast heavy ion on neutral atomic oxygen. Comparisons with theoretical calculations and other experimental data were made where possible. (auth)

52676 STUDY OF THE DISCREPANCY BETWEEN PRIOR AND POST APPROXIMATIONS IN QUANTUM CALCULATIONS OF THE e–H EXCITATION CROSS SECTIONS BY THE CORRELATIONS METHOD. **Felden, Madeleine M.; Felden, Marceau A. (Laboratoire de Physique des Milieux Ionises, Nancy). Phys. Rev., A; 4: No. 4, 1476-81(Oct 1971).**

In the calculation of excited-state cross sections for electron impact on hydrogen atoms, the hypothesis $A = \vec{\nabla}_1 \ln\phi_j (\vec{r}_1) \cdot (\vec{\nabla}_R \ln g_j^\ddagger - \vec{\nabla}_\rho \ln g_j^\ddagger) = 0$ is used to solve the Schrödinger equation of the system. The purpose of this work is to take into account this term assuming that $\vec{\nabla}_1 \ln\phi_j (\vec{r}_1)$ is equal to a constant vector $\vec{C}_j$ dependent on the atomic state under consideration. Taking into account the justification and the consequences of this hypothesis, the equation of the system is solved when one puts the term A into this form. The transition amplitudes T_{0n} are calculated by "prior" and "post" approximations and compared, and the cross sections are obtained and discussed for four transitions. These various results show that the introduction of the term A favors the prior approximation because it is expressed by a constant modification of the incident electron energy, which is not the case for the post approximation. (auth)

52677 DIFFERENTIAL AND INTEGRAL CROSS SECTIONS FOR THE ELECTRON-IMPACT EXCITATION OF THE $a^1\Delta_g$ AND $b^1\Sigma_g^+$ STATES OF O_2. **Trajmar, S. (California Inst. of Tech., Pasadena); Cartwright, D. C.; Williams, W. Phys. Rev., A; No. 4, 1482-92(Oct 1971).**

Electron-impact energy-loss spectra of O_2 were analyzed for incident electron energies from 4 to 45 eV, scattering angles from 10° to 90°, and energy losses from 0 to 5 eV. The inelastic processes observed were the excitation of the $a^1\Delta_g$ and $b^1\Sigma_g^+$ electronic states and vibrational excitation in some cases to $v'' = 13$. The excitation cross sections at each energy were made absolute by normalizing the sum of the integral cross sections (all inelastic, ionization, and elastic) to measured electron–O_2 total cross sections. The differential cross sections for the $a^1\Delta_g$ and $b^1\Sigma_g^+$ states show nearly isotropic behavior, as expected for optically spin-forbidden transitions. The elastic differential cross sections are strongly forward peaked at higher energies, but become only slightly forward peaked at the lower energies. The integral cross sections for the excitation of the $a^1\Delta_g$ and $b^1\Sigma_g^+$ states reach their maxima near 7 eV and are more than an order of magnitude larger than previous estimates. The integral elastic cross section reaches its maximum at around 10 eV. (auth)

52678 EIKONAL THEORY OF INTERMEDIATE-ENERGY ELECTRON–ATOM SCATTERING. **Joachain, Charles J.; Mittleman, Marvin H. (Univ. of California, Berkeley). Phys. Rev., A; 4: No. 4, 1492-9(Oct 1971).**

An eikonal theory of elastic electron–atom scattering in the region of intermediate energies is proposed. In addition to the effects of the static and polarization potentials, the leading absorption corrections are also taken into account, using the equivalent-potential method. Detailed calculations are performed for elastic electron–helium scattering in the energy range 100 to 500 eV. The results are in good agreement with recent experimental data. (auth)

52679 THEORETICAL INVESTIGATION OF COMPLEX POTENTIALS FOR ATOMIC COLLISIONS. II. SEMICLASSICAL DESCRIPTIONS OF ATOMIC COLLISIONS. **Mizuno, Junya; Chen, Joseph C. Y. (Univ. of California, San Diego, La Jolla). Phys. Rev., A; 4: No. 4, 1500-17(Oct 1971).**

Semiclassical approximations are applied to atomic collisions with complex potentials. The effects of damping due to the imaginary parts of the complex potentials are investigated in the JWKB and eikonal approximations. Numerical illustrations are given for a model (H^-, H) system constructed in Paper I of this series. The calculated results for such a model are compared with available experimental measurements for electron-transfer and collisional-detachment processes in the (H^-, H) collision system at high energies. Important differences, which come primarily from the inadequacy of the model potentials and the nonadiabatic effects, are found between the theoretical and experimental results. (auth)

52680 COUPLED-EQUATION THEORY WITH A SELF-CONSISTENT OPTICAL POTENTIAL FOR SCATTERING AND REARRANGEMENT COLLISIONS. **Chen, Joseph C. Y.; Chung, Kwong T.; Sinfailam, A.-L. (Univ. of California, San Diego, La Jolla). Phys. Rev., A; 4: No. 4, 1517-29(Oct 1971).**

A set of coupled equations with a self-consistent optical potential explicitly expressed in terms of a set of functions constructed to account for the polarization, correlations, and short-range interactions is derived for scattering and rearrangement collisions. Applications of the self-consistent coupled equations to several atomic collision problems are considered. Numerical illustrations are given for the investigation of the resonance structures in elastic (e, H) scatterings. (auth)

52681 IMPROVED PERTURBATION THEORY FOR INELASTIC ENCOUNTERS. **Roberts, R. E. (Indiana Univ., Bloomington). J. Chem. Phys.; 55: No. 1, 100-4(1 Jul 1971).**

An improved perturbation theory for inelastic bimolecular collisions is proposed, which is based upon the suitable choice of an effective distortion potential derived from a second-order adiabatic optical potential. Since the new theory involves simply a rescaling of the original effective interaction, essentially no additional labor is required to obtain the corrected transition probabilities, at least for the special case of a one-dimensional problem. For example, an application to the prototype problem of vibrational relaxation, namely the collinear collision of an atom with a harmonic oscillator, reduces the error of the usual distorted-wave approximation from 116% to 5%, averaging over all cases for which exact multistate results exist for comparison. Furthermore, a simple prediction concerning the accuracy of the distorted-wave approximation for resonance transitions is borne out by exact results. (auth)

52682 MATRIX SHAPE APPROACH TO SCATTERING THEORY. **Rabitz, Herschel A. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 55: No. 1, 407-23(1 Jul 1971).**

A nonperturbative method of solving scattering problems is presented. It is based on the shape of the potential matrices involved. The matrices are expanded in a basis set whose arguments are the quantum numbers of the system. The resulting set of simultaneous linear equations is easily solved. A numerical example of collinear collisions of an atom and a diatomic vibrator is considered, and the effect of potential matrix shape on the inelastic transition probabilities is investigated. (auth)

52683 NEW SELECTION RULE ILLUSTRATED BY COLLISION CROSS SECTION STUDIES ON THE $B^1\Sigma^+ \leftarrow X^1\Sigma^+$ AND THE $C^1\Sigma^+ \leftarrow X^1\Sigma^+$ TRANSITIONS IN CARBON MONOXIDE AT KINETIC ENERGIES OF 300, 400, AND 500 eV. **Skerbele, Ausma; Lassettre, Edwin N. (Carnegie–Mellon Univ., Pittsburgh). J. Chem. Phys.; 55: No. 1, 424-34(1 Jul 1971).**

Generalized oscillator strengths were determined at 300, 400, and 500 eV for the two transitions $B^1\Sigma^+ \leftarrow X^1\Sigma^+$ and $C^1\Sigma^+ \leftarrow X^1\Sigma^+$ in carbon monoxide. The Born approximation does not hold accurately for either transition. The largest deviations (percentage wise) are found for the first of the above transitions, and the trend of oscillator strength with momentum change (of the colliding electron) is very different from anything previously observed. This abnormal behavior is also found in relative intensity measurements done at low kinetic energies (to 23 eV). These transitions were studied because recent experimental and theoretical investigations [J. Chem. Phys., 53: 3801, 3806(1970)] indicated that deviations from the Born approximation at high kinetic energies are subject to a selection rule; the deviations are maximum when term symbols are the same in ground and excited states. Previous experimental tests have been done only on forbidden transitions. The experiments reported in the present paper show that the deviations also occur for allowed transitions in which term symbols are the same in ground and excited states. Previous experiments are also reconsidered with a view to testing the selection rule hypothesis. (auth)

Atomic Theory

Refer also to abstract 53387.

52684 QUANTUM STATISTICAL THEORY OF SUPERRADIANCE. II. Bonifacio, R. (Univ., Milan); Schwendimann, P.; Haake, Fritz. Phys. Rev., A; 4: No. 3, 854-64(Sep 1971).

The solution of the "superradiance master equation" derived in a preceding paper is discussed. During the first few photon transient times the cooperative atomic decay goes through a nonadiabatic oscillatory regime. For later times the decay takes place monotonically in time with the electromagnetic field following it adiabatically. The emitted light pulse has different statistical properties for an incoherently and a coherently prepared "superradiant" atomic initial state. The former case is characterized by large quantum fluctuations and strong atom–atom and atom–field correlations. In the latter case quantum fluctuations are small and the system behaves essentially classically. By also solving for a class of coherently prepared intermediate initial states it is shown that large quantum fluctuations occur only if the initial total occupancy of the excited state differs from the total number of atoms at most by a number of order unity. (auth)

52685 STRUCTURE OF HEAVY ATOMS: THREE-BODY POTENTIALS. Mittleman, Marvin H. (Univ. of New York, N. Y.). Phys. Rev., A; 4: No. 3, 893-900(Sep 1971).

A discussion of the problem of the construction of a configuration-space Hamiltonian describing a many-electron atom with relativistic effects included is given. It appears that the total three-body energy in such an atom must be small if the problem of the construction of this Hamiltonian is to be simply solvable. To that end, a relativistic three-body potential is constructed for a three-electron system. It has novel terms that arise from a pathology of the two-body Hamiltonian previously noted. It is shown that a speculative generalization to the many-electron system results in a total three-body energy which may be many rydberges but which is still a small perturbation on the total result. (auth)

52686 LARGE PHOTON CORRELATIONS IN MANY-ATOM SPONTANEOUS EMISSION. Ponte Goncalves, A. M.; Tallet, A. (Laboratoire de Photophysique Moleculaire, Orsay, France). Phys. Rev., A; 4: No. 3, 1319-21(Sep 1971).

The normalized second-order correlation function is calculated for the spontaneous emission of radiation from many-atom systems. Very large photon correlations appear as the systems decay to the ground state. This effect is shown to be a consequence of the quantization of the radiation field. (auth)

52687 RELATIVISTIC TREATMENT OF TRANSITION PROBABILITIES IN ATOMS. Feneuille, S. (CNRS, Orsay, France). Physica; 53: No. 1, 143-9(17 May 1971). (In French).

The equivalent operator formalism is used to investigate matrix elements that appear in the relativistic calculation of atomic transition probabilities. Operators are obtained, which, when evaluated between nonrelativistic states, produce the same results as obtained in a relativistic treatment. These operators, when reduced to the nonrelativistic limit, are shown to be identical with the usual multipole expansion. (auth)

52688 COMPLETION OF THE SET OF PROPER STATES OF THE RELATIVISTIC HYDROGEN ATOM. Hautot, A. P. (Univ., Liege). Physica; 53: No. 1, 154-6(17 May 1971). (In French).

It is shown how the use of the quaternionic formalism makes it possible to prove that the set of proper states of the relativistic hydrogen atom is complete. It seems that this statement was missing up to now. (auth)

52689 APPLICATION OF THE GROUP SU_3 TO THE THEORY OF THE MANY-ELECTRON ATOM. Haskell, T. G. (Univ. of Canterbury, Christchurch, N. Z.); Wybourne, B. G.; Feneuille, S. Physica; 53: No. 1, 64-76(17 May 1971).

The possibility of the group SU_3 being used in the description of the $(d + s)^N$ and $(d + s)^N p^m$ many-electron complexes is examined by symmetrization of the Coulomb hamiltonian. By dividing the Coulomb interaction into symmetry-conserving and symmetry-violating terms it is found that although the SU_3 scheme tends to give a better description of the $(d + s)^N$ complexes it is of no significance in the $(d + s)^N p^m$ complexes. (auth)

52690 DIRECT CALCULATION OF FIRST- AND SECOND-ORDER DENSITY MATRICES: THE HIGHER RPA METHOD. Simons, Jack (Univ. of Wisconsin, Madison). J. Chem. Phys.; 55: No. 3, 1218-30(1 Aug 1971).

A procedure for approximately determining the first- and second-order density matrices of pure-state N-fermion systems is presented. A higher random-phase approximation is used to derive a method in which the resulting density matrices are approximated self-consistently in an iterative scheme. As test calculations, the method is applied to the ground states of the helium, lithium, and beryllium atoms. The possibility and importance of obtaining error bounds involving the density matrices are discussed. (auth)

52691 DISTINGUISHABLE-ELECTRON METHOD (DEM) FOR ELECTRONIC STRUCTURE CALCULATIONS. II. DERIVATION OF ACCESSIBLE CORRELATION EXPRESSIONS FOR PHYSICAL PROPERTIES AND APPLICATION TO THE POLARIZABILITY OF TWO-ELECTRON ATOMS. Kirtman, Bernard; Mowery, Robert L. (Univ. of California, Santa Barbara). J. Chem. Phys.; 55: No. 3, 1447-56(1 Aug 1971).

The distinguishable-electron method is extended to the calculation of physical properties other than the energy. Such calculations utilize accessible correlation expressions containing no correlated wave functions. It is shown that the necessary perturbation functions can be obtained from solutions of one-electron differential equations. For purposes of illustration, the method is applied to the polarizability of the helium sequence, starting with an open-shell screened-nucleus initial approximation. Three different sets of optimized screening constants are employed. The best set—obtained by a new procedure that depends upon the property—yields polarizabilities that agree well with experiment and are superior to the perturbed coupled Hartree–Fock method. (auth)

52692 TWO ALGORITHMS FOR CHOOSING OPTIMUM PARAMETERS IN VARIATION–PERTURBATION CALCULATION OF PHYSICAL PROPERTIES. Kirtman, Bernard (Univ. of California, Santa Barbara). J. Chem. Phys.; 55: No. 3, 1457-60 (1 Aug 1971).

Two algorithms for choosing optimum parameters in the variation–perturbation calculation of physical properties are presented. These algorithms are based on a judicious combination of the Rayleigh–Ritz variation principle with a stationary condition on that property. Some examples are discussed. (auth)

52693 ELECTRON PAIR CORRELATION: PRODUCTS OF N(N-1)/2 GEMINALS FOR N ELECTRONS. Silver, David M. (Johns Hopkins Univ., Silver Spring, Md.). J. Chem. Phys.; 55: No. 3, 1461-7(1 Aug 1971).

The use of an antisymmetrized product of an N-electron spin eigenfunction and N (N – 1)/2 geminals to form an N-electron, correlated wave function is proposed for atoms and molecules. This approach is more general than previous geminal-product schemes in that the wave function explicitly contains a different geminal for each of the pair interactions present in the system. By describing the geminals in terms of bilinear orbital expansions, the formalism remains quite tractable. The example of three pairs of electrons is used to exhibit explicit expressions for density matrices, energy, and variational equations, which hold for any desired choice of spin and orbital angular momentum state. (auth)

52694 DIFFERENT PERTURBED UNCOUPLED HARTREE–FOCK (PUCHF) METHODS FOR PHYSICAL PROPERTIES. I. THEORY AND DIPOLE POLARIZABILITIES. Tuan, Debbie Futai (Kent State Univ., Ohio. Harvard Univ., Cambridge, Mass.); Davidz, Andreas. J. Chem. Phys.; 55: No. 3, 1286-93(1 Aug 1971).

Two different kinds of uncoupled Hartree–Fock (UCHF) methods, Method $C_{1/2}$ and Method C_0, for the calculation of second-order physical properties are proposed. They differ from Dalgarno's uncoupled Hartree–Fock method (Method C_1) by including half of the self-potential or not including the self-potential at all. They are formulated with a zeroth-order many-electron Hamiltonian, and first-order correction of both methods can be obtained without knowledge of the second-order orbitals. This situation is similar to the case studied by Tuan and co-workers for Method C_1. The dipole polarizabilities for the He and Be isoelectronic sequences were calculated by the three UCHF methods, $\alpha_{UCHF} = \alpha_0$, by the three UCHF methods with the first-order perturbation correction (PUCHF methods), $\alpha_{PUCHF} = \alpha_0 + \alpha_1$, and by the geometric approximation based on these three PUCHF methods, $\alpha_{geom} = \alpha_0(1 - \alpha_1/\alpha_0)^{-1}$. The significance of the difference in the self-potential is demonstrated by comparing the results with results from the coupled Hartree–Fock (CHF) method. Method $C_{1/2}$, which included the intermediate amount of self-potential, gave the best comparison of α_0, $\alpha_0 + \alpha_1$ and α_{geom} with α_{CHF}. For the He isoelectronic sequence from Method $C_{1/2}$, α_0 differs from α_{CHF} by 9.71% to 2.26%, $\alpha_0 + \alpha_1$ differs from α_{CHF} by 1.29% to 0.08%, and α_{geom} differs from α_{CHF} by 0.42% to 0.03%. Errors in the Be isoelectronic sequence are larger than those in the He isoelectronic sequence. Explanations in terms of the restricted forms of the Hartree–Fock wave function and of the variational first-order orbitals are given. The relative computing times for the CHF method and the perturbed version of Method $C_{1/2}$ are in the ratio of 5 to 1. It is suggested that for evaluating the physical properties of larger and complicated systems the geometric approximation based on the PUCHF Method $C_{\frac{1}{3}}$ can replace the CHF method as a simple and accurate method. (auth)

52695 DIFFERENT PERTURBED UNCOUPLED HARTREE–FOCK (PUCHF) METHODS FOR PHYSICAL PROPERTIES. II. DIPOLE SHIELDING FACTORS. **Tuan, Debbie Fu-tai (Kent State Univ., Ohio. Harvard Univ., Cambridge, Mass.); Davidz, Andreas. J. Chem. Phys.; 55: No. 3, 1294-9(1 Aug 1971).**

The dipole shielding factors for the He and Be isoelectronic sequences have been calculated by the three uncoupled Hartree–Fock (UCHF) methods, $\gamma_{UCHF} = \gamma_0$, by the three UCHF methods with the first-order perturbation correction (PUCHF methods), $\gamma_{PUCHF} = \gamma_0 + \gamma_1$, and by the geometric approximation based on the three PUCHF methods, $\gamma_{geom} = \gamma_0(1 - \gamma_1/\gamma_0)^{-1}$. The significance of the different amounts of self-potential included in the three PUCHF methods is demonstrated by comparing the results with results from coupled Hartree–Fock (CHF) calculations and the theoretical values. For the He isoelectronic sequence the PUCHF Method $C_{\frac{1}{3}}$ is considered to be the best. The range of error of γ_0 compared with γ_{CHF} is 0.14% to 0.49%. The range of error of $\gamma_0 + \gamma_1$ or of γ_{geom} compared with γ_{CHF} is of 0.01% to 0.13%. Larger errors in the Be series are attributed to the restricted forms of the Hartree–Fock wave function and the variational first-order orbitals. (auth)

52696 CORE-ELECTRON BINDING ENERGIES AND SLATER ATOMIC SHIELDING CONSTANTS. **Snyder, Lawrence C. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys.; 55: No. 1, 95-9(1 Jul 1971).**

The Slater–Zener expression for the energy of an atom is generalized to include hypothetical states for which the Slater atomic shielding constants do not minimize the energy. The generalized energy expression is used with Slater's rules for atomic shielding constants to study the Koopmans' theorem ionization potential for core electrons and its dependence on nuclear charge and the number of valence electrons on an atom. An electronic relaxation energy for x-ray states is defined and is shown to be proportional to the number of electrons in shells outside the core hole, independent of nuclear charge, and quadratic in the change of shielding constant for each shell upon core-hole formation. Finally, arguments are given to show that the core hole should be thought of as localized, even when there are several equivalent atomic sites over which it may be delocalized. (auth)

52697 EXCHANGE- AND CORRELATION-ENERGY CALCULATIONS IN FINITE SYSTEMS. **Tong, B. Y. (Univ. of Western Ontario, London). Phys. Rev., A; 4: No. 4, 1375-80 (Oct 1971).**

In the local-effective-potential approximation of the Kohn–Sham self-consistent scheme applied to an atomic system, it was reported that, although the calculated exchange energies for various atoms were accurate to within 10%, the correlation energies of atoms were too large by a factor of 2. A model system is set up to study the reason why the exchange energy estimates are so much better than those of the correlation energy even though they were treated on the same footing. It was found that, in using expressions derived from an infinite electron gas system to study finite systems, the major source of error comes from the fact that the low-lying levels of a finite system are discrete and have finite spacings. The replacement of summation by integration in the perturbation diagrams results in an overestimate of correlation energy and a small error in the exchange energy in a finite system like an atom. (auth)

52698 OBSERVABILITY OF REARRANGEMENT ENERGIES AND RELAXATION TIMES. **Meldner, H. W.; Perez, J. D. (Univ. of California, San Diego, La Jolla). Phys. Rev., A; 4: No. 4, 1388-96(Oct 1971).**

A clarification of the often misunderstood concept of rearrangement that affects particle removal from finite fermion systems is presented. A separation energy is defined, which depends on the speed of removal as a result of physical rearrangement processes. It is shown how single-particle eigenvalues can be observed when a single-particle description applies to the many-body system. Calculations of atomic rearrangement energies are discussed, and a linear Z dependence is derived. The photo-ionization spectrum for 1s electrons from Ne is used as a quantitative example to extract rearrangement energy and time. Possible application to nucleon-removal data analysis is discussed. (auth)

52699 THEORY OF ATOMIC STRUCTURE INCLUDING ELECTRON CORRELATION. IV. METHOD FOR FORBIDDEN-TRANSITION PROBABILITIES WITH RESULTS FOR [O I], [O II], [O III], [N I], [N II], AND [C I]. **Nicolaides, Cleanthis (Yale Univ., New Haven); Sinanoglu, Oktay; Westhaus, Paul. Phys. Rev., A; 4: No. 4, 1400-10(Oct 1971).**

Electric quadrupole transition probabilities for the oxygen-atom auroral line $^1S_0 - {}^1D_2$ (λ = 5577 Å) and the $^2P - {}^2D$, $^1S - {}^1D$ lines in C I, N I, N II, O II, and O III, which are of atmospheric and astrophysical interest, are calculated. The nonclosed-shell many-electron theory (NCMET) of atomic structure developed by Sinanoğlu and co-workers, which treats electron correlation accurately in both ground and excited states, predicts novel correlation effects, which are included in the wave functions used to calculate the transition probabilities. These are many-body calculations on "forbidden" lines, the first of their kind. The effect of electron correlation on the quadrupole line strengths is explicitly examined. It is found that the Hartree–Fock values are reduced by 13 to 17% when all the important correlation effects are included in the wave functions. In view of the accuracy of the wave functions and of the method of calculation, the results obtained are expected to be accurate with a less than 5% uncertainty. For the much discussed O I $^1S_0 - {}^1D_2$ (5577 Å) transition it is found that $A_Q = 1.183\ sec^{-1}$. Comparison is made with previous experimental and theoretical work. (auth)

Cosmic Radiation

Refer also to abstracts 51887, 52580, 52989, 53018, 53144, and 53238.

52700 ABSOLUTE COSMIC RAY MUON SPECTRUM AT SEA LEVEL. **Allkofer, O. C.; Carstensen, K.; Dau, W. D. (Univ., Kiel). Phys. Lett.; 36B: No. 4, 425-8(20 Sep 1971).**

The absolute vertical muon intensity in the range 0.2 to 1000 GeV/c was determined from four different measurements. The best fit differential and integral intensities turned out to be 10 to 25% higher than previous spectra, which have usually been normalized to the intensity at 1 GeV/c given by Rossi in 1948. (auth)

52701 ENERGY DEPENDENCE OF THE PRESSURE COEFFICIENT OF THE COSMIC-RAY NEUTRON FLUX. **Aurela, A. M.; Vuorinen, K. (Turku Univ., Finland). Ann. Univ. Turk., Ser. A1; No. 134, 1-8(1970).**

The dependence of the pressure coefficient α of the cosmic-ray neutron flux on the neutron energy E_n was studied in the geomagnetic latitude 58°N at an altitude of 45 m in Turku, Finland, by means of a paraffin–BF_3 spectrometer. The following values and standard deviations were obtained for α: $-(8.8 \pm 0.6)\%$/cm Hg for $E_n < 10^4$ eV, $-(9.63 \pm 0.42)\%$/cm Hg for $10^5\ eV \lesssim E_n \lesssim 10^7$ eV, and $-(8.86 \pm 0.55)\%$/cm Hg for $10^6\ eV \lesssim E_n \lesssim 10^8$ eV. The last value of α agrees with the value $\alpha = -(8.92 \pm 0.13)\%$/cm Hg obtained by Nobles et al. (1967) from sea-level multiplicity measurements, which refer to energies $10^7\ eV < E_n < 10^8$ eV. The present measurements with the moderator thickness 5 cm, which is sensitive to evaporation neutrons ($E_n \approx 10^6$ eV), suggested a large value for $|\alpha|$ (11%/cm Hg). This would agree with the large values obtained by Nobles et al. for the high-energy neutrons ($E_n \approx 10^8$ to 10^9 eV) that produce most of the evaporation neutrons. (auth) (Finland)

52702 FOUNDATION OF THE THEORY OF COSMIC-RAY TRANSPORT IN RANDOM MAGNETIC FIELDS. **Klimas, A. J.; Sandri, G. (Aeronautical Research Associates of Princeton, Inc., N. J.). Astrophys. J.; 169: No. 1, 41-56(1 Oct 1971).**

A new closed pair of coupled integro-differential equations for the cosmic-ray omnidirectional intensity and flux in a random magnetic field with uniform mean part are derived from first principles. The only assumptions made to obtain this result are: (1) the cosmic-ray pressure tensor is isotropic, (2) higher than two-point correlations in the random field are neglected, (3) the two-point correlation tensor corresponds to isotropic, homogeneous turbulence, and (4) spatial inhomogeneities in the omnidirectional intensity and flux are negligible over the scale of the correlation length. These equations are valid for all energies compatible with assumption (2). In the asymptotic limit of infinite energy, these equations are shown to reduce to the high-energy results of Jokipii. For finite energies and, in particular, for energies where solar modulation effects have been observed, it is shown that presently available theories of cosmic-ray transport or modulation are incorrect. These theories all result from an adiabatic approximation of the equations presented here; but it is shown that, because of the helical particle trajectories in the mean magnetic field, the kernel in the integro-differential flux equation decays slowly (∝1/time) for any random field two-point correlation function (or equivalently for any power spectrum). This slow decay leads to spurious divergences in the adiabatic approximation of the relevant transport coefficients. (auth)

Direct Energy Conversion

Refer also to abstract 54044.

XUM

52703 (A/CONF.49/P-592) DEVELOPMENT OF THERMIONIC CONVERSION WITH A VIEW TO ENERGY PRODUCTION. Devin, B.; Bailly, J.; Francois, B.; Schwartz, J. P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1971. 13p. (CONF-710901-402). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Programs pursued during the last seven years by the CEA and the DRME with the technical assistance of the THOMSON-CSF Company have shown that converter laboratory lifetime has exceeded 20,000 hours while approximately 5000 hours operation have been recorded in in-pile operation; many factors that influence converter performance have been established. Material choice and quality have been correlated with converter performance. Chemical vapor deposition methods have been developed to give oriented tungsten emitter surfaces which have long-term, high-temperature stability. Sophisticated technology has evolved in the form of high-vacuum-assembly devices. Integral cesium reservoirs, autoregulating reservoirs, and model reactor fuel rods have been built and operated. An irradiation program was undertaken with both UO$_2$ and MoUO$_2$ fuel forms in order to determine long-term stability of the emitter structure. This program should also reveal the necessity, if any, of venting fission products generated in the fuel. The critical reactor configuration, water cooled and moderated, was calculated: the result of the calculations was compared with critical experiments carried on in the reactor EOLE. On these experiments the influence of configuration and materials is investigated in a "driver core" concept. That is one in which the thermionic converters are surrounded by an active fuel zone. Such a reactor as finally envisioned will be extremely reliable and long-lived without maintenance. The present program objectives will be with a 10-kW(e) experiment. This objective should yield the necessary data required to design and build a 100-kW(e) reactor. (auth)

52704 (A/CONF.49/P-721) DEVELOPMENT OF ISOTOPIC POWER TECHNOLOGY IN THE USSR. Fradkin, G. M.; Brezhneva, N. E.; Ershova, Z. V.; Bogdanov, N. I.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 27p. (CONF-710901-421). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Consideration is given to the sources and methods of production of a number of radioisotopes and fuel materials as well as to the problems of developing heater blocks on the basis of cerium-144, strontium-90, cesium-137, plutonium-238, polonium-210, cobalt-60, and promethium-147; there are some basic radiophysical characteristics of the heater blocks on the basis of the radioisotopes mentioned above. Calculations referring to shielding and heat generation are given, and different requirements in the choice of a heater design and the development of a heat converter are discussed as well. (M.O.W.)

52705 (IAE-2021) STUDY OF THE EFFICIENCY OF ELECTRIC POWER GENERATION AT THERMAL ELECTRIC POWER PLANTS WITH FARADAY-TYPE OPEN-CYCLE MHD GENERATORS. Gubarev, A. V.; Nosov, I. G. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 104p. (In Russian). Dep. NTIS (U. S. Sales Only).

Theoretical studies of the circuits of (stationary) power generating facilities incorporating open-cycle MHD generators are reviewed. It is shown that, owing to the current indefinitiveness in the selection of starting data, and as a result of the calculation of principal circuit elements according to excessively high indicators, there exists a marked lack of uniformity in the design formulas presented by different authors. A calculation procedure is presented that includes the detailed consideration of principal circuit elements (combustion chamber, duct, diffuser, the steam-power part of the station, etc.) of a facility incorporating an MHD generator fueled by the combustion products of solid fuel. In addition, a theoretical study of circuits with optimization relating to a number of specific parameters (pressure in combustion chamber, air heating temperature, etc.) is presented. It is shown that if power stations with MHD generators are to successfully compete with conventional thermal electric power stations, a number of problems of engineering physics must be solved, including the following: (1) a marked reduction in end losses in the duct of the magnetohydrodynamic generator; (2) development of a magnetic superconducting system designed for the field induction $B \geq 4$T with volumes $V \geq 10$ m^3; and (3) assurance of an efficient utilization of the heat of the cooling walls in the steam-power part of the cycle. (JPRS)

52706 (JPRS-53939) MATERIALS FOR MHD GENERATOR CHANNEL. Rekov, A. I. (ed.). Translation of Materialy dlya Kanala MGD-Generatora, Nauka, Moscow, 1969. 229p. NTIS.

The composition, structure, and properties of refractory nonmetal structural materials (oxides, concrete, carbides, etc.) developed for various magnetohydrodynamic generator assemblies are investigated. Special attention is devoted to erosion stability, electric conductivity, thermal emissivity, emissivity, and also to the thermomechanical strength and vaporization of materials. (auth)

52707 DEVICE FOR TRANSFERRING HEAT TO A DUCTED FLOW OF LIQUID PHASE MATERIAL. (to Licentia Patent-Verwaltungs-GmbH). British Patent 1,242,750. 11 Aug 1971. Priority date 27 Nov 1967, Germany.

A device is described for transferring heat to a ducted flow, in a thermodynamic circuit, of material that is in a liquid phase and that has a relatively high vaporization temperature so as partially to vaporize the material. Thus, a two-phase flow of low vapor content is formed in which the liquid phase comprises a stream of droplets of the material substantially uniformly distributed in the vapor phase. The device comprises a heat exchanger consisting, on its secondary side, of a plurality of substantially parallel ducts, each of substantially uniform cross section except for the presence of a constriction at a precisely located throttle point. This constriction is such that, in use, the liquid-phase flow is separated from the two-phase flow by the constriction, the liquid-phase material upstream of the constriction being heated to at least its incipient boiling temperature. (M.H.R.)

52708 POSSIBLE ADVANCE IN THERMIONIC CONVERSION. Harrowell, R. V. (Central Electricity Research Lab., Leatherhead, Eng.). Electron. Lett.; 7: No. 17, 486-7(26 Aug 1971).

A theory is outlined by which a thermionic converter might operate at an anode-cathode spacing of about 1 mm, thus removing a major drawback to the exploitation of this direct generator of electric power. Successful testing of the theory could lead to a new low-pollution multifuel power unit. (auth)

Fluid Physics

52709 MAGNETOHYDRODYNAMIC DUCT FLOW IN A UNIFORM TRANSVERSE MAGNETIC FIELD OF ARBITRARY ORIENTATION. Alty, C. J. N. (Univ. of Warwick, Eng.). J. Fluid Mech.; 48: 429-61(16 Aug 1971).

An approximate analysis is presented for high Hartmann number of the flow of an electrically conducting, incompressible fluid in a duct of square cross section, having one pair of opposite walls insulating, and the other pair perfectly conducting and inclined at arbitrary orientation to a uniform transverse magnetic field. The flow is considered to be either pressure-driven with the two perfectly conducting electrodes short-circuited together or electrically driven by a potential difference applied between these electrodes in the absence of axial pressure gradient. Experiments are described on the pressure-driven, short-circuited case using mercury in copper ducts to investigate the variation of the streamwise pressure gradient and of the potential distribution along one insulating wall with orientation, magnetic field and flow rate. At general orientations the analysis suggests and the experiments confirm the existence of regions of stationary fluid in the corners of the duct, together with viscous shear layers parallel to the magnetic field. For the case in which the electrodes are parallel to the magnetic field the experimental results for the pressure gradient, but not those for the potential distribution, agree reasonably well with Hunt & Stewartson's (1965) asymptotic solution. Both pressure gradient and potential results agree closely with the analysis by Hunt (1965) of the case in which the electrodes are perpendicular to the magnetic field. (auth)

52710 MHD FLOW IN AN ANNULAR CHANNEL: THEORY AND EXPERIMENT. Baylis, J. A. (Central Electricity Research Labs., Surrey, Eng.); Hunt, J. C. R. J. Fluid Mech.; 48: 423-8(16 Aug 1971).

The theory of Hunt & Stewartson (1965) for MHD flow in a rectangular duct with conducting walls parallel and nonconducting walls perpendicular to the magnetic field is applied to the problem of electrically driven MHD flow in a rectangular annulus. It is assumed that the Hartmann number M is sufficiently great for secondary flow effects to be negligible. The experiment described here satisfied the conditions of the theory and thus provides a sensitive experimental check on Hunt & Stewartson's theory. The theory is found to agree with the experiments to within the accuracy of the asymptotic theory. (auth) (UK)

52711 DIAGRAM REPRESENTATION OF THE ISOTROPIC HYDROMAGNETIC TURBULENCE IN AN INCOMPRESSIBLE FLUID. Codreanu, Steliana (Babes-Bolyai Univ., Cluj). Stud. Cercet. Fiz.; 23: No. 3, 311-26(1971). (In Rumanian).

After an introductory discussion of MHD turbulence, the author expands diagrammatically on the method of Lawrence L. Lee

(Ann. Phys. (N. Y.), 32: 292(1965)) whose theory of isotropic hydromagnetic turbulence in incompressible fluids was formulated using methods similar to those of quantum field theory. Then, approximations for the correlation function equations are calculated. (L.M.T.)

52712 BOUNDARY-LAYER STRUCTURE AT A MAGNETOHYDRODYNAMIC REAR STAGNATION POINT. Buckmaster, J. (New York Univ., University Heights). Quart. J. Mech. Appl. Math; 24: 373-86(Aug 1971).

The viscous boundary layer equations of magnetohydrodynamics are examined in the vicinity of a rear stagnation point under the assumption of small magnetic Reynolds number. It is known that if the interaction parameter N (based on the local velocity gradient) satisfies the inequality $1 < N < 2$, a similarity solution of the form $u = xf'(y)$ is not appropriate but, on the other hand, separation does not occur before the stagnation point is reached. The local structure for this special range of N is examined. Essentially two layers are required, one of which is inviscid, and the basic features obtained are in agreement with numerical computations. Two additional layers are required to complete the solution, one dividing the two main layers, the other describing the flow at large distances from the wall. The latter is apparently unsteady and the possible implications of this are discussed. (auth) (UK)

52713 STABILITY OF PLANE MAGNETOHYDRODYNAMIC COUETTE FLOW WITH ASYMMETRIC VELOCITY PROFILE. Sagalakov, A. M. Zh. Prikl. Mekh. Tekh. Fiz.; No. 3, 12-18 (May-Jun 1971). (In Russian).

The hydrodynamic stability of a plane magnetohydrodynamic Couette flow was investigated in the framework of linear theory, with asymmetric velocity profile, formed by a transverse magnetic field. The complete spectrum of small perturbations was examined for characteristic Hartmann numbers. A classification of perturbations was made in conformity with the behavior of their phase velocities at large wave numbers. It was established that the current stability was controlled only by one type of perturbation. The critical parameters of the problem were determined. The instability suggested the instability of Hartmann flow by the relation to the asymmetric perturbation. (tr-auth)

52714 END EFFECTS IN MAGNETOHYDRODYNAMIC DUCTS FOR FINITE MAGNETIC REYNOLDS NUMBERS. Vasil'ev, V. F.; Lavrent'ev, I. V. Zh. Prikl. Mekh. Tekh. Fiz.; No. 3, 19-27 (May-Jun 1971). (In Russian).

From a solution to the problem of the distribution of magnetic fields induced during motion of the medium in a plane duct with conducting walls in the presence of a nonhomogeneous field, it was possible to analyze the influence of the magnetic Reynolds number, the wall conductivity, and the geometry of the external magnetic field on the character of the distribution of the induced currents, of the electric and magnetic fields around the cross section of the duct, and the Joule loss. (tr-auth)

52715 UNSTEADY MAGNETOHYDRODYNAMIC COUETTE FLOW DURING CONSTANT DISCHARGE OF CONDUCTING FLUID. Kuznetsov, S. E. Zh. Prikl. Mekh. Tekh. Fiz.; No. 3, 144-7(May-Jun 1971). (In Russian).

An approximation solution was obtained for the problem of laminar nonstationary Couette flow, caused by a change in the applied magnetic field, during a constant discharge of an incompressible, viscous, conducting fluid between two plane, parallel walls (one stationary and the other moving). Magnetohydrodynamic equations were used with a small magnetic Reynolds number. It was found that, in steady operation, in the presence of the magnetic field the fluid velocity gradient at the stationary duct wall increased in proportion to the MHD current at all V_f/V ratios. At the moving wall the gradient could either increase or decrease, depending on the value of V_f/V. Here V = the constant velocity of the wall in motion (of the two parallel walls), and V_f = the average flow velocity in the fluid. (tr-auth)

Geophysics (Upper Atmosphere)

Refer also to abstract 52699.

52716 RESONANCE MECHANISM FOR ENERGIZATION OF ELECTRONS IN MAGNETOPLASMA. III. Nath, Omkar; Singh, R. N. (Banaras Hindu Univ., India). Int. J. Electron.; 31: No. 3, 249-55(Sep 1971).

The well-known cyclotron resonance mechanism was studied and energization of electrons in the magnetosphere was explored. The relativistic variation of electron mass in the resonance process was considered and the consequence of neglecting the relativistic electron mass variation was discussed. At or near resonance the electron motion conforms with the motion of electrons in a potential well. Calculating the shape of the pseudo-potential for the magnetospheric plasma, the energy gained by the electrons was calculated. A 1-eV electron resonating with the electromagnetic wave ($\omega = 10^7$ rad sec^{-1} and $E = 10^{-7}$ esu) acquires 1 MeV after 1.88 sec. The geophysical effect of the proposed energization is discussed. (auth)

52717 REMOTE DOUBLE RESONANCE COUPLING OF RADAR ENERGY TO IONOSPHERIC IRREGULARITIES. Kennel, C. F. (Univ. of California, Los Angeles). Comments Astrophys. Space Phys.; 3: No. 3, 87-93(May-Jun 1971).

It is suggested that low-frequency modulation of a high-power radar beam, tuned to one of the critical frequencies of the ionosphere, may produce field-aligned density irregularities when the modulation frequency matches that of an ionospheric eigenfrequency. By choosing the radar carrier frequency and polarization, a number of interaction layers can be selected. In addition, there are a large number of resonant eigenmodes of low frequencies that could be excited by nonlinear coupling. Each of the waves is different and, of course, their properties may vary with the ionosphere from day to day; however, all the couplings may be investigated simply by sweeping the radar modulation frequency through the whole range of expected frequencies. The variety of possible excitations indicates that the double-resonance technique may be adaptable to a number of different objectives. (W.D.M.)

52718 COMMENTS ON THE EMISSION FEATURE AT 11.7 cm^{-1}. Gebbie, H. A. (Univ. of Colorado, Boulder); Bohlander, R. A.; Murcray, D. G. Nature (London) Phys. Sci.; 232: No. 33, 156(16 Aug 1971).

Reference is made to Beery (Nature Phys. Sci., 230: 36(1971)) who attributes an emission feature observed at 11.7 cm^{-1} in the atmosphere to N_2O, and it is stated that the calculated amount of N_2O to account for this observation is about 50 times that indicated by near-infrared measurements; it is thought that the latter are not in error by so large an amount. It is, therefore, thought that assignment of the feature to N_2O is doubtful. It is considered that, until the questions of the contributions of the little-understood species such as water dimers are resolved, observations of extraterrestrial sources in the mm and sub-mm region that are made through the atmosphere should be interpreted with caution. (UK)

52719 APPLETON'S LAST NOTE ON THE E-REGION SEASONAL ANOMALY. Muggleton, L. M. (Univ. of Edinburgh). J. Atmos. Terrest. Phys.; 33: No. 9, 1291-7(Sep 1971).

A note outlining the progress of the work in which Appleton was engaged at the time of his death is reproduced as written, together with graphs reconstructed from basic data. The influence of latitude and the value of χ on the Appleton E-region seasonal anomaly are indicated. It is concluded that at any station the value of $(f_0E)^2$, and hence $N_m(E)$, is lower in local summer than in local winter for the same value of χ, that this effect is not influenced by the value of constant-χ chosen, and that the amplitude of the variation is characteristic of the latitude of the station. (UK)

52720 EFFECT OF SUN–EARTH DISTANCE ON E-REGION IONIZATION. Muggleton, L. M. (Univ. of Edinburgh). J. Atmos. Terrest. Phys.; 33: No. 9, 1299-1305(Sep 1971).

The effect of the Earth's orbital eccentricity on $(N_m)E$ was investigated. Values of $(f_0E)^2_{noon}$ at some 20 observatories, averaged over a solar cycle and stripped of seasonal effects, provided the basic data. By combining the data from mirror-image months the scatter was reduced. It was found that Sun–Earth distance control of a Chapman-like model of the E region is describable by the relationship $(N_m)E \propto (f_0E)^2 \propto d^{-1.2} = d^{-2m}$ where d is the ratio of the Sun–Earth distance at the time of interest to the yearly average of the distance. Noting that, for the same model, $(f_0E)^2 \alpha \cos^n \chi$, some significance is attached to the fact that both m and n were found to be equal to about 0.6 instead of 0.5, the value applicable to a recombination law for the electron-loss mechanism. (auth)

52721 SOLAR-CYCLE CONTROL OF $N_m(E)$. Muggleton, L. M. (Univ. of Edinburgh). J. Atmos. Terrest. Phys.; 33: No. 9, 1307-10(Sep 1971).

The regression coefficients between E-region peak electron density, $N_m(E)$, and sunspot number, R, depend on the particular solar cycle investigated. It is found that a representative worldwide relationship for the 1949–59 solar cycle is given by $N_m(E) \propto (f_0E)^2 \propto (1 + 0.00334\ R)$. (auth)

52722 ELECTRODYNAMIC-DRIFT EFFECTS IN MIDLATITUDE F-REGION STORM PHENOMENA. Jones, K. L. (Univ.

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of Queensland, Brisbane). J. Atmos. Terrest. Phys.; 33: No. 9, 1311-19(Sep 1971).

Calculations were performed of changes in N_mF2 due to vertical drifts associated with electric fields in the storm-time midlatitude F region. Vertical drifts depend on changes of electric-field strength and vanish after a short time for steady fields in the daytime F region because of motion set up in the neutral air. Various forms of electric-field variation were used. Electrodynamic drifts may be responsible for one type of reported phenomenon but not for the very large increases in N_mF2 which are sometimes observed. One result of interest is that a sinusoidal electric field produces drifts which probably cause a net increase in N_mF2. A "circuit analogue" method was developed to estimate the vertical drifts caused by electric fields in the F region. (auth)

52723 REQUIREMENTS FOR ROCKET AURORAL SPECTROSCOPY IN THE VACUUM ULTRAVIOLET. Catchpoole, J. R. (York Univ., Toronto). J. Atmos. Terrest. Phys.; 33: No. 9, 1329-36(Sep 1971).

Detection of the features of the auroral uv spectrum and the measurement of their relative intensities are of diagnostic importance to the theory of physical processes in the upper atmosphere. With specific reference to preparations for rocket spectroscopic observations on the aurora, some relevant preliminary calculations are reported that deal especially with the likely effects of atmospheric absorption on the overall instrumental sensitivity. Probable effective viewing times and required auroral intensities are discussed. (auth)

52724 SEMI-DIURNAL WIND AND TEMPERATURE OSCILLATIONS IN THE E REGION OBSERVED BY THE NANCAY INCOHERENT SCATTER EXPERIMENT. Bernard, R.; Spizzichino, A. (CNET-GRI, Issy-les-Moulineaux, France). J. Atmos. Terrest. Phys.; 33: No. 9, 1345-52(Sep 1971).

A correlation method applied to the wind and temperature data obtained between 95 and 140 km from an incoherent-scatter experiment shows a prevailing semi-diurnal oscillation whose phase propagates downwards. It can be interpreted as a semi-diurnal tide, but with quite different wavelength from that at lower altitudes. (auth)

52725 FURTHER INVESTIGATIONS OF THE EFFECTS OF NEUTRAL-AIR WINDS ON THE IONOSPHERIC F LAYER. Eccles, D. (SRC Radio and Space Research Station, Slough, Eng.); King, J. W.; Kohl, H. J. Atmos. Terrest. Phys.; 33: No. 9, 1371-81(Sep 1971).

Ionospheric data obtained at middle latitudes during summer are compared with values of f_0F2 calculated by solving simultaneously the F-layer continuity equation and the equation of motion of the neutral atmosphere. The "evening enhancements" and "midnight maxima" of f_0F2 which occur over certain regions of the Earth in summer are shown to be caused almost entirely by neutral-air winds. These winds produce very different ionospheric effects at similar latitudes in the northern and southern hemispheres. Certain day-to-day changes in the diurnal behavior of the ionosphere at sunspot minimum could be explained if the phase of the wind differs from day to day; such changes in the phase of the wind need not necessarily be accompanied by corresponding changes in the time at which the atmospheric diurnal bulge occurs. Diurnal variations of f_0F2 having different shapes are observed at different solar epochs, and these can be reproduced theoretically provided that the effects of neutral-air winds are included in the calculations. (auth)

52726 SELF-CONSISTENT SOLUTION OF THE QUASI-LINEAR THEORY: APPLICATION TO THE SPECTRAL SHAPE AND INTENSITY OF VLF WAVES IN THE MAGNETOSPHERE. Roux, A.; Solomon, J. (Groupe de Recherches Ionospheriques, St.-Maur, France). J. Atmos. Terrest. Phys.; 33: No. 9, 1457-71(Sep 1971).

During a gyroresonant interaction taking place inside the magnetosphere, the relaxation of the warm-electron anisotropy, due to quasi-linear effects, changes the growth rate of the vlf waves. A self-consistent treatment of this process makes it possible to compute the frequency spectrum of these waves. Assuming that the energy diffusion of electrons occurs in a characteristic time much larger than the time required for pitch-angle diffusion, the coupled system which consists of the diffusion equation for particles and energy conservation for waves can be solved in a self-consistent way. Such a method is similar to the one used by Drummond and Pines (1962) to compute the quasi-linear spectrum in the electrostatic case. In the specific case of emission by magnetospheric electrons, the results of the computation is in agreement with satellite data from the point of view of both the spectral shape and of the wave intensity. (auth)

52727 E x B INSTABILITY IN AURORAL ARCS. Hooper, E. B. Jr.; Walker, J. C. G. (Yale Univ., New Haven). J. Atmos. Terrest. Phys.; 33: No. 9, 1441-55(Sep 1971).

The E × B instability is predicted to occur in auroral arcs, where it generates oscillations which propagate in the E × B direction with speeds of several hundred meters per second, and which have wavelengths of about 1 km. The instability may cause oscillations in an otherwise quiescent plasma, or cause the growth of fluctuations occurring in the source of ionization. The dispersion relation is derived under conditions corresponding to the auroral oval, including the effects of ion—electron recombination and the effects of the vertical variation of collision frequencies. The instability occurs when the horizontal gradient of the logarithm of the electron density exceeds a value of 0.5×10^{-4} m^{-1}, so that auroral arcs with a width of less than 20 km should exhibit the instability. The instability occurs only on one side of an auroral arc (the side where the electric potential is high) so an asymmetry is predicted to be produced in the distribution of plasma about the center of narrow auroral arcs. (auth)

52728 SOME NEW ASPECTS OF THE WINTER ANOMALY OF IONOSPHERIC ABSORPTION. Taubenheim, J. (Zentralinstitut fuer Solar-Terrestrische Physik, Berlin). J. Atmos. Terrest. Phys.; 33: No. 9, 1481-5(Sep 1971).

Newly published data on air pressures in the upper atmosphere suggest that seasonal variations of the collision frequency in the D and lower E region are larger than expected before. The height and latitude dependences of these variations are surprisingly well in accord with the corresponding characteristics of the winter anomaly. Further it is shown that seasonal changes of the relative concentrations of molecular and atomic oxygen, as postulated to explain the seasonal anomaly in the F layer, will also give rise to excessive electron densities in winter in the region of strong short-wave absorption around 100-km height. (auth)

52729 PARAMETERS OF INTERNAL GRAVITY WAVES DEDUCED FROM ELECTRON CONTENT. Liszka, L. (Kiruna Geophysical Observatory, Sweden). J. Atmos. Terrest. Phys.; 33: No. 9, 1487-92(Sep 1971).

A method is described for deducing the parameters of internal gravity waves from the short-term variations of total electron content. It is used to analyse the electron content deduced during nine transits of the beacon satellite S-66. (auth)

Low-Temperature Physics and Cryogenic Equipment

Superfluidity

52730 ORIGIN OF BOUND STATES OF ^{3}He ATOMS ON FREE SUPERFLUID ^{4}He SURFACES. Saam, W. F. (Ohio State Univ., Columbus). Phys. Rev., A; 4: No. 3, 1278-81 (Sep 1971).

An approximate theory of the motion of a ^{3}He atom in the vicinity of a superfluid ^{4}He surface is presented. The theory predicts a bound state of the ^{3}He atom in the vicinity of the surface, in accord with experimental results. The theoretical value for the energy of this state (measured with respect to the ^{4}He chemical potential) is within 35% of the experimentally determined value. (auth)

52731 ISING MODEL FOR THE λ TRANSITION AND PHASE SEPARATION IN ^{3}He—^{4}He MIXTURES. Blume, M. (Brookhaven National Lab., Upton, N. Y.); Emery, V. J.; Griffiths, Robert B. Phys. Rev., A; 4: No. 3, 1071-7(Sep 1971).

A spin-1 Ising model, which simulates the thermodynamic behavior of ^{3}He—^{4}He mixtures along the λ line and near the critical mixing point, is introduced and solved in the mean-field approximation. For reasonable values of the parameters of the model the phase diagram is qualitatively similar to that observed experimentally and the phase separation appears as a consequence of the superfluid ordering. Changing the parameters produces many different types of phase diagram, including as features λ lines, critical points, tricritical points, and triple points. Certain thermodynamic features that differ from the ^{3}He—^{4}He experiments may be artifacts of the mean-field theory. (auth)

52732 FORWARD-SCATTERING AMPLITUDES AND FERMI-LIQUID FACTORS IN DILUTE SOLUTIONS OF ^{4}He IN LIQUID ^{3}He. Saam, W. F. (Ohio State Univ., Columbus). Phys. Rev., A; 4: No. 3, 1122-6(Sep 1971).

A derivation of exact expressions, given in terms of thermodynamic quantities, for the s-wave parts of the ^{3}He—^{4}He and ^{4}He—^{4}He quasi-particle forward-scattering amplitudes in very dilute solutions of ^{4}He in liquid ^{3}He is given. The result for the p-wave part of the ^{3}He–^{4}He amplitude is related to the ^{4}He quasi-particle effective mass. The associated Fermi-liquid parameters are also derived. (auth)

52733 THEORY OF DILUTE SOLUTIONS OF ^{4}He IN LIQUID ^{3}He AT LOW TEMPERATURES. Saam, W. F. (Ohio State Univ., Columbus); Laheurte, J. P. Phys. Rev., A; 4: No. 3, 1170-5(Sep 1971).

Expressions for the l = 0 forward scattering amplitudes for ^{3}He–^{4}He and ^{4}He–^{4}He quasi-particle pairs in dilute solutions of ^{4}He in liquid ^{3}He are derived in terms of thermodynamic quantities. A Fermi-liquid theory of the solutions is developed, and various thermodynamic quantities are derived. The theory agrees well with the available experimental data. (auth)

52734 TRANSFER OF THE HELIUM FILM BETWEEN 0.3K AND THE λ POINT. Martin, D. J.; Mendelssohn, K. (Clarendon Labs., Oxford). J. Low Temp. Phys.; 5: No. 2, 211-25(Aug 1971).

A high-accuracy method for measuring helium-level changes was developed. Measurements made above 1°K were in agreement with the generally accepted behavior of the helium film. A very slight dependence of the transfer rate R on the level difference was observed at all level differences. Below ~1°K the transfer shows an entirely new pattern: R increases and becomes strongly dependent on the level difference. The transfer also displays some metastability, two distinct rates being possible at the same temperature, level difference, and barrier height. Measurements of the inertial oscillations indicate that there is no increase in the film thickness at low temperatures. (auth)

52735 DISCONTINUOUS FIELD-VELOCITY RELATION FOR VORTEX RINGS IN SUPERFLUID SOLUTIONS. Kuchnir, M.; Ketterson, J. B.; Roach, P. R. (Argonne National Lab., Ill.). Phys. Lett.; 36A: No. 4, 287-8(13 Sep 1971).

The simultaneous existence of two different ring velocities observed in dilute ^{3}He–^{4}He solutions below 45 mK can be interpreted as evidence for the existence of rings with different quanta of circulation or a resonance in the ring–^{3}He scattering cross section. (auth)

52736 MOBILITY OF NEGATIVE IONS ALONG SUPERFLUID VORTICES. Ohmi, Tetsuo; Usui, Tunemaru (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1717-23(Jun 1971).

The mobility of negative ions along superfluid vortices is calculated on the basis of an appropriate model. The finite trapping force is taken into account, giving a resonance peak in the reflection coefficient of the vortex waves. The Doppler effect due to the ion motion is also taken into consideration. The numerical result is compared with experiment. (auth)

Superconductivity

52737 (IS-T-482) SUPERCONDUCTIVITY OF Pb-Bi ALLOYS UNDER HIGH PRESSURE. Jones, Robert Edwin Jr. (Ames Lab., Iowa). Sep 1971. Contract W-7405-eng-82. 129p. Dep. NTIS.

Thesis.

The superconducting behavior of $Pb_{0.4}$–$Bi_{0.6}$ alloys was studied under pressure to 20 kbar using piston-cylinder devices with a clamp technique. Nearly hydrostatic conditions were achieved by use of powdered Teflon or a 1: 1 mixture of isoamyl alcohol and pentane as pressure-transmitting media; a Sn manometer was employed to determine the pressure directly at cryogenic temperatures. The superconducting transitions were detected by ac susceptibility measurements. At low pressures, these alloys are a mixture of two different phases: α, the rhombohedral phase which is nearly pure Bi, and β, the hcp phase with 33 to 40 at. % Bi; however, a pressure of 16 kbar or more at room temperature transforms these alloys into a dhcp phase. This dhcp phase was found to be superconducting with a T_c of approximately 8.0°K, which is slightly less than the T_c of 8.5°K of the $\alpha-\beta$ phase. The depression of T_c with pressure is nearly the same for either phase with $dT_c/dP = -(1.3 \pm 0.15) \times 10^{-2}$ k/kbar and $d\ln T_c/d\ln V = 0.39 \pm 0.05$, but the magnitude of these effects is smaller than those usually reported for nontransition elements and their alloys. The observed critical field curves (near H_{c3}) of both phases were investigated up to 20 kG, and the critical field curve of the dhcp phase was found to be somewhat steeper than that of the $\alpha-\beta$ phase. The shapes of the critical field curves of both phases are in fairly good agreement with those predicted by the Abrikosov and Gor'kov pair-breaking theory. The critical field curve of the dhcp phase was depressed by increased pressure with $dH_{c2}(0)/dP = -0.42$ kG/kbar. This is a larger effect than would have been expected from the results of pressure work on other superconductors. (auth)

52738 SPECIFIC HEAT STUDY OF SUPERCONDUCTING ALLOYS WITH MAGNETIC IMPURITIES: $La_{3-x}Gd_xAl$ SYSTEM. Mamiya, Takayoshi; Aoi, Toshio; Iwahashi, Katsutoshi; Masuda, Yoshika (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 31: No. 2, 485-96(Aug 1971).

The effects of magnetic impurities on superconductors $La_{3-x}Gd_xAl$ containing up to 2 at. % Gd were studied extensively, mainly by specific-heat measurements. In the range of temperature and impurity concentration investigated, the superconducting transition temperature T_c as a function of impurity concentration agrees well with the theoretical curve of Abrikosov and Gor'kov. The magnetic ordering temperature T_M observed as the temperature at which the specific heat reaches a maximum is lower than T_c. Absence of departure from the Abrikosov–Gor'kov curve results in the fact that the magnetic ordering has no effect on T_c in the temperature range above T_M. Generally, the upper critical field H_{c2} decreases linearly with increasing Gd content. The examination of the behaviors of H_{c2} gives the possible presence of the effect of the magnetic ordering on H_{c2} below the temperature range studied. The nature of the magnetic ordering is discussed. (auth)

52739 MAGNETIC SUPERCONDUCTORS. Peter, M. (Univ., Geneva); Donze, P.; Fischer, O.; (and others). Helv. Phys. Acta; 44: No. 3, 345-58(15 May 1971). (In German).

The theory of magnetic superconductors is critically reviewed and it is shown that the restrictions such as: ion–electron exchange scattering, exchange fields, weakening of the RKY coupling, and orbital fields will, in certain cases at least, not prevent the coexistence of magnetism and superconductivity. The thermodynamical potential for magnetic superconductors is established and partially evaluated in the appendix. Then recent magnetization–dilation and specific-heat measurements on $Ce_{(1-x)}Gd_xRu_2$ are presented, and it is concluded that this system is a homogeneous magnetic superconductor at low temperatures. The magnetic properties of this system are also unusual since the Gd–Gd exchange interaction is strongly proportional to the temperature in the region investigated. (auth)

52740 SUSCEPTIBILITY OF ELECTRONS IN A SUPERCONDUCTOR. Nam, Sang Boo (Univ. of Virginia, Charlottesville). J. Korean Phys. Soc.; 4: No. 1, 13-16(Mar 1971).

The Landau diamagnetic susceptibility of electrons in a superconductor was calculated by pairing the Landau states of electrons in a magnetic field. It was found that the Landau diamagnetic susceptibility has a contribution of the order of Δ/μ from the pairing. The spin paramagnetic susceptibility of electrons due to the states with energy less than the gap parameter in a superconductor was also calculated, and it was found that the spin paramagnetic susceptibility of electrons is proportional to the Ginzburg–Landau parameter at zero temperature. (auth)

52741 ENHANCEMENT OF SUPERCONDUCTIVITY OF LANTHANUM AND YTTRIUM SESQUICARBIDE. Krupka, Milton C.; Giorgi, Angelo L.; Krikorian, Nerses H.; Szklarz, Eugene G. (to United States Atomic Energy Commission). U. S. Patent 3,586,641. 22 Jun 1971. Filed 18 Jul 1969.

A method of enhancing the superconductivity of bcc lanthanum and yttrium sesquicarbide through formation of the sesquicarbides from ternary alloys of novel composition $(N_xM_{1-x})C_z$ is described, where N is yttrium or lanthanum, M is thorium, any of the Group IV and VI transition metals, or gold, germanium or silicon, and z is approximately 1.2 to 1.6. These ternary sesquicarbides have superconducting transition temperatures as high as 17.0°K. (auth)

52742 MICROSCOPIC THEORY OF STRONG-COUPLING, ANISOTROPIC SUPERCONDUCTORS NEAR THE CRITICAL TEMPERATURE IN THE PRESENCE OF A MAGNETIC FIELD. Menyhard, Nora (Central Research Inst. for Physics, Budapest). Magy. Fiz. Foly.; 19: No. 2, 105-57(1971). (In Hungarian).

On the basis of the microscopic theory of superconductors involving the Ginzburg–Landau equations, a generalized, frequency-dependent, effective electron–electron interaction was used to derive the equations describing the behavior of strong-coupling superconductors in a magnetic field at $T \lesssim T_c$. It was found that the Ginzburg–Landau equations may be applied to this type of superconductors near the transition temperature. This is explained by the fact that as T_c is approached, the movement of the degrees of freedom of the particles become independent and the parameters of the equations are changed. A generalized expression was derived for the parameters for the case of zero external field. The anisotropic effect was also taken into account, generalizing Gorkov's and Melik–Barkhudarov's studies on the behavior of superconductors in a magnetic field. The shape of the anisotropic electron–electron interaction was derived on the basis of the electron–phonon interaction under consideration of the crystal anisotropy effects. (TTT)

XUM

52743 THERMAL CONDUCTIVITY OF SUPERCONDUCTING NIOBIUM. Moore, Byron Keith. Urbana, Ill.; Univ. of Illinois (1971). 139p. University Microfilms Order No. 71-21,188. Thesis.

A study of the magnetic field and temperature dependence of the thermal conductivity of superconducting niobium was made for three single crystals of varying purity. The residual resistivity ratios (R300/R4.2) were: Nb–1% Ta, 27; Wah Chang Nb, 200; Linde Nb, 2000. The magnetic fields applied varied from zero to values greater than the upper critical field H_{c2}. The fields were applied both parallel and perpendicular to the direction of the thermal gradient. The temperature dependence was measured from 0.33 to 12.0°K. The superconducting state conductivity Ks of all three samples exhibited a distinct peak near 2.0°K. This peak is related to enhancement of the lattice conductivity as the electrons are frozen into the superconducting ground state. In the case of the Nb–1% Ta, Ks exceeded Kn in the vicinity of the peak. The temperature dependence of Ks below the peak has been shown to vary with purity and state of mechanical deformation. Below 1.0°K, Ks for the Linde sample showed a $T^{2.6}$ temperature dependence and a value in excess of that calculated for boundary scattered phonon conductivity. There was no conclusive evidence for the existence of a second energy gap for the Linde sample. Ks/Kn as a function of magnetic field showed a minimum for H just greater than H_{c1} in all three samples. In the case of the Nb–1% Ta, $(Ks/Kn - 1) \propto (H_{c2} - H)$ for H near H_{c2} in agreement with the theory of Caroli and Cyrot for dirty Type-II superconductors. For the other two samples, $(Ks/Kn - 1) = A(H_{c2} - H)^{1/2}$ for H near H_{c2} in agreement with the Maki theory for clean Type II materials. Measurements made with axial and transverse magnetic fields verified Maki's predicted anisotropy for the coefficient A. The temperature dependence of the coefficient was found to be in fair agreement with that predicted by the theory. However, the value calculated for the density of states at the Fermi surface was found to decrease markedly with increasing sample purity. These values were considerably smaller than those reported from specific heat measurements. (Diss. Abstr. Int., B)

52744 SIZE OF QUANTIZED VORTEX RINGS IN LIQUID HELIUM II. Gamota, G.; Sanders, T. M. Jr. (Univ. of Michigan, Ann Arbor). Phys. Rev., A; 4: No. 3, 1092-9(Sep 1971).

The energy dependence of the size of quantized vortex rings in He-II is measured by studying the transmission of charged vortex rings through grids with holes of the order of a micron. A maximum-energy ring which can be transmitted is found for each hole size. These cutoffs are interpreted geometrically and lead to a relationship between ring size and energy which supports the quantization of circulation and the applicability of classical hydrodynamics to this problem. The circulation κ and core radius a of the rings are determined to be $\kappa = (1.002 \pm 0.03) \times 10^{-3}$ cm^2 sec^{-1} and $a = (0.90 \pm 0.50) \times 10^{-8}$ cm. (auth)

52745 SUPERCONDUCTING MATERIALS. Electronics Design Materials, Chapter 6. Kamper, R. A. Electronic Engineering Series. Basingstoke, Eng.; MacMillan Press (1971). 224p. £3.50.

A short general explanation of the superconducting state is followed by sections on: bulk properties (zero resistance, the Meissner effect, and Type I and Type II superconductors), thin films and tunnel junctions, and the Josephson effect. 59 references. (UK)

52746 DETERMINATION OF THE ENERGY GAP OF A SUPERCONDUCTING TIN/LEAD SANDWICH BY ELECTRON TUNNELING. Gilabert, A. (Faculte des Sciences, Nice); Romagnan, J. P.; Guyon, E. Solid State Commun.; 9: No. 15, 1295-7(1 Aug 1971).

The superconductivity of Sn films backed by thick Pb films were investigated by electron tunneling in Pb/Pb O/Sn/Pb junctions. Two limiting forms of the variation of the energy gap as a function of temperature for the Sn/Pb sandwiches were obtained that are in good agreement with the theory of MacMillan. (auth)

52747 SUPERCONDUCTING DENSITY OF STATES INDUCED BY THE PROXIMITY EFFECT. Freake, S. M. (Cambridge Univ., Eng.). Phil. Mag.; 24: No. 188, 319-38(Aug 1971).

The excitation spectra induced by the superconducting proximity effect in superimposed thin films of copper and lead were measured. The experiments were done at temperatures in the range 0.06 to 0.11°K, so that an energy resolution of about 15 μ eV was obtained. On the copper side of specimens with copper films less than 1500 Å thick, the scale of the gap structure was in agreement with McMillan's theory (1968) using no adjustable parameters. However, the detailed form of the density of states was different. In particular, a smeared gap edge, a dip in the density of states at an energy close to the lead gap for a certain range of copper thicknesses, and evidence for the existence of states at zero energy were observed. On the lead side of the sandwich the excitation spectra were gapless for thin lead films (<1000 Å) backed by 2000 Å copper. As predicted by McMillan (1968), thicker lead films exhibited an energy gap equal to that on the remote side of the copper, and many states at energies less than the lead gap. (auth) (UK)

52748 YIELD AND RECOVERY OF THE FLUX LINE LATTICE IN A TYPE-II SUPERCONDUCTOR. Good, Jeremy A. (Oxford Univ.); Kramer, Edward J. Phil. Mag.; 24: No. 188, 339-57(Aug 1971).

Sweep-rate-dependent hysteresis was observed in the voltage–current curves of a deformed niobium crystal at 4.2°K. This phenomenon was investigated quantitatively by observing the current necessary to maintain a constant voltage V as a function of time. Increases in the current with time (recovery) occurred following the imposition of a current in the flux flow regime, a decrease in magnetic field from above H_{c2} or a rotation of the crystal in the field. Recovery proceeded at a rate roughly proportional to V, and no recovery occurred if V was held at zero. Decreases in the current (yield) occurred if the magnetic field was increased from zero before V was imposed. The magnitude of the current drop at yield was proportional to V at low V and the yield time was proportional to V^{-1}, although it was much shorter than the recovery time. Yielding is thought to result from the multiplication of flux-carrying defects, specifically flux line dislocation (FLD) dipoles, in the flux line lattice (FLL). The voltage and time dependence of yield were in agreement with the predictions of a theory of FLD dipole dynamics. Recovery was tentatively attributed to the purging of sources of FLD dipoles from regions of low pin density within the crystal. (auth) (UK)

52749 THERMODYNAMIC LIMIT OF THE B.C.S. STATE. Fano, G. (Univ., Bologna); Loupias, G. Commun. Math. Phys.; 20: No. 2, 143-66(1971).

Vector states in the Fock representation of the C.A.R. algebra, representing condensed pair states, are considered. It is proven that, in the thermodynamic limit, these states give rise to a direct integral of gauge-dependent BCS states. (auth)

52750 PAIR-BREAKING EFFECTS IN THE SUPERCONDUCTING KONDO ALLOY LaCe. Umlauf, E. (Zenralinstitut fuer Tieftemperaturforschung, Garching, Ger.); Schneider, J.; Meier, R.; Kreuzer, H. J. Low Temp. Phys.; 5: No. 2, 191-5(Aug 1971).

The depression of the superconducting transition temperature of LaCe alloys and the upper critical field $H_{c2}(T)$ of La and LaCe was measured down to 0.05°K. The results disagree with calculations, based on recent theories, including the temperature dependence of the spin–flip amplitude. (auth)

52751 MICROWAVE STUDIES OF SUPERCONDUCTING SURFACE SHEATH IN PURE AND ALLOYED LEAD. Kirschenbaum, Jay Haren. Stony Brook, N. Y.; State Univ. of New York (1971). 146p. University Microfilms Order No. 71-19,611. Thesis.

Measurements of the microwave surface resistance at 24 Gc were used to determine the nucleation field (H_{c3}) of the superconducting surface sheath in pure single crystal lead, and a 0.25% bismuth in lead. Values of H_{c3} were obtained over the temperature range $0.228 < t < 0.673$ for the pure material, and over the range $0.235 < t < 0.970$ for the alloy. $t = T/Tc$ is the reduced temperature. In the case of the alloy, the slope $(dH_{c3}/dT)|T_c$ is found to agree with the predictions of Eilenberger and Ambegoakar based on the strong coupling Ginzburg–Landau theory, provided that the difference between the bulk and surface d/c conductivities is accounted for. The temperature dependence of H_{c3} is found to be in reasonably good agreement with the results obtained from the microscopic theory by Hu and Korenman. The data for pure lead agrees best with that reported by Smith and Cardona, and Rosenblum and Cardona. Other reported H_{c3} values disagree with each other and with results found here. The temperature dependence of H_{c3} is found to be in satisfactory agreement with the theory of Hu and Korenman. Measurements of the temperature dependence of the anisotropy in the surface resistance versus magnetic field curve were obtained for pure lead. The anisotropy occurs when the dc magnetic field is rotated from a direction parallel to a direction perpendicular to the microwave electric field. In the latter configuration, there is additional absorption due to the excitation of short-lived collective modes of the surface sheath. The results are compared with the theory presented by Maki and Fischer based on the generalized Ginzburg–Landau theory. (Diss. Abstr. Int., B)

52752 EFFECTS OF AC FIELD ON DEPINNING CURRENT DENSITY IN TYPE-II SUPERCONDUCTORS. Yamafuji, K.;

Sakamoto, N.; Kawashima, T. (Kyushu Univ., Fukuoka). Phys. Lett.; 36A: No. 4, 341-2(13 Sep 1971).

A remarkable decrease of dc depinning current density was observed recently when an ac magnetic field of small amplitude was applied. A simple explanation of this fact is provided here in case of a linear fluxoid lattice. (auth)

52753 MICROMAGNETISM AND SUPERCONDUCTIVITY. **Eringen, A. Cemal (Princeton Univ., N. J.). J. Math. Phys. (N. Y.); 12: No. 7, 1353-8(Jul 1971).**

The balance laws of microelectromagnetic theory developed by Eringen and Kafadar [J. Math. Phys. 11, 1984 (1970)] are shown to contain, as special cases, the classical theories of micromagnetism and London's equation of superconductivity. Various generalizations are indicated. (auth)

52754 MICROSCOPIC THEORY OF DILUTE ^{3}He–He II SOLUTIONS. I. DERIVATION OF HYDRODYNAMIC EQUATIONS WITHOUT VISCOUS TERMS. **Galasiewicz, Z. M. (Univ., Wroclaw). Acta Phys. Pol.; A40: No. 2, 145-56(Aug 1971).**

The Khalatnikov hydrodynamic equations for dilute ^{3}He–He II solutions are obtained on the basis of microscopic theory proposed by Bogolyubov. (auth)

52755 MICROSCOPIC THEORY OF DILUTE ^{3}He–He II SOLUTIONS. II. LINEARIZED HYDRODYNAMIC EQUATIONS AND GREEN FUNCTIONS. **Galasiewicz, Z. M. (Univ., Wroclaw). Acta Phys. Pol.; A40: No. 2, 157-64(Aug 1971).**

After solving the linearized hydrodynamic equations the expressions for the retarded thermodynamic Green functions for ^{3}He–He II solutions are obtained in the long-wavelength low-frequency domain. The density–density Green functions have singularities only for the energies of the first sound quanta. (auth)

52756 RESISTIVITY OF SUPERCONDUCTING ALLOYS IN THE MIXED STATE IN A WEAK FIELD. **Gilchrist, J.; Monceau, P. (CNRS, Grenoble, France). J. Phys. Chem. Solids; 32: No. 9, 2101-4(Sep 1971).**

The resistivity of lead–indium alloys in the mixed state was determined as a function of temperature T in different magnetic fields, H_0. The temperature variation confirms previous experimental and theoretical results but it was found that $\rho_f/\rho_n \approx H_0/1.2H_{c2}$ as $T \rightarrow 0$, differing from the empirical law of Kim et al (1965). (auth)

52757 DETERMINATION OF THE ELECTRON–PHONON COUPLING CONSTANT FROM OPTICAL MEASUREMENTS. **Maksimov, E. G.; Motulevich, G. P. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 1, 414-18(Jul 1971). (In Russian).**

The electron–phonon coupling constant λ is determined from optical measurements at temperatures exceeding the Debye value. The constant enters the expression for the renormalized electron mass on the Fermi surface and also the expression for the superconducting transition temperature. The determination is based on a simple relation between λ and the electron relaxation time due to electron–phonon interaction at temperatures above the Debye value when the complete phonon oscillation spectrum is excited. The values of λ for Pb, Sn, In, Al, Zn, Nb, V, Nb_3Sn and V_3Ga derived from optical measurements are compared with those obtained by other methods. (auth)

52758 FLUCTUATION IN SUPERCONDUCTING LEAD THIN FILMS ABOVE THE TRANSITION TEMPERATURE. **Mizusaki, Takao. New Brunswick, N. J.; Rutgers–The State Univ. (1971). 138 p. University Microfilms Order No. 71-20,058. Thesis.**

The effect of fluctuation on the dc conductivity above the transition temperature, T_c, was studied. The resistance of Pb films was measured near T_c in zero field and in transverse magnetic fields. Excellent agreement with the theoretical functional dependence of the extra conductance $\Sigma'(O,T)$ in zero field and $\Sigma'(H,T)$ in magnetic field was obtained except for the three most impure specimens. The transition temperature, T_c, and the normal state resistance, R_n, were obtained from experiment. In films for which the coherence length is large compared to the thickness of the film, the extra conductance is given by $\Sigma'(O,T) = \beta/\epsilon\ W/L$, where $\epsilon = (T - T_c/T_c)$, L is the length and W is the width of the film. According to the theory of Aslamazov and Larkin $\beta = (e^2/16\hbar)$. It was found that β tended to be larger than the theoretical value. Although the total range of variation of β is much less than that observed in Al films and of the same order as that observed in Bi films, it is felt that the observed various values of β cannot be accounted for by experimental error. The disagreement of β with theoretical value seems to be largest in the most impure specimens. It appears that the observed values of β can be related to microscopic inhomogeneities in the specimens. A model is proposed that describes the effect of grain-structure type inhomogeneity on the extra conductivity. The model is consistent with the measured value of β. The large values of β found in Al films can also be qualitatively understood. (Diss. Abstr. Int., B)

52759 INDIRECT MEASUREMENT OF THE SUPERCONDUCTING PAIR DENSITY ABOVE T_c IN $La_{3-x}Gd_xIn$ DUE TO THERMODYNAMIC FLUCTUATIONS. **Hoenig, H. E.; Wang, R. H. (California Inst. of Tech., Pasadena). Phys. Rev. Lett.; 27: No. 13, 850-2(27 Sep 1971).**

A temperature-dependent lowering was observed of the paramagnetism of Gd ions in $La_{3-x}Gd_xIn$ ($x = 0.064$) above the critical temperature. This effect is attributed to the influence of thermodynamic fluctuations of the superconducting order parameter on the Pauli spin susceptibility affecting in this way the indirect coupling of Gd spins. The result is in qualitative agreement with recent calculations by Fulde and Straessler. (auth)

52760 MIXED-STATE ULTRASONIC ATTENUATION IN CLEAN NIOBIUM NEAR H_{c2}: FIELD DEPENDENCE FOR $\vec{q} \parallel \vec{H}$. **Carsey, Frank (Univ. of California, Los Angeles); Levy, Moises. Phys. Rev. Lett.; No. 13, 853-6(27 Sep 1971).**

Ultrasonic attenuation measurements are reported for clean niobium in the region from $H_{c2} - H = 100$ G to $H_{c2} - H = 0$. The results agree qualitatively with the theory of Maki and Houghton which develops regimes of attenuation which are "gapless' near the transition and BCS-like farther away. (auth)

52761 HIGH-FIELD HIGH-CURRENT SUPERCONDUCTORS. **Rassmann, Guenther; Mueller, Peter (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). Neue Huette; 16: No. 6, 321-30(Jun 1971). (In German).**

Possibilities for increasing the critical field in superconductors are discussed with respect to inhomogeneities and radiation-induced defects. Based on the Matthias rule, transition temperature and electron structure are treated. Assessment of the highest transition temperature achievable in metallic superconductors yields 40°K. Cables containing super and normal conductors are described; the effect of the ratio between superconductor and copper is analyzed as well as the filament diameter in multifilament cables. It is shown that it is possible to produce compound conductors containing superconductors that can be properly shaped. 27 references. (H.B.G.)

Equipment and Devices

52762 OPTIMIZATION OF SUPERCONDUCTIVE SOLENOIDS. **Chovanec, Frantisek. Elektrotech. Cas.; 22: No. 6, 413-27 (1971). (In Slovak).**

Important superconductive solenoid parameters—the magnetic field in the center of the inner diameter, the winding volume, and the used superconductor volume—are dependent on the value of the mean current density in the winding. It is known that in unstabilized superconductive solenoids the mean current density can be higher in some cases than in cryostatically stablized superconductive solenoids. The problem is investigated of when and under which conditions it is more advantageous from the viewpoint of winding weight and superconductor consumption, to design unstabilized solenoids instead of cryostatically stablized ones. One possible solution of this problem is given. The suggested calculation method is illustrated on a sample solenoid produced from the superconductor 65 BT (Nb–Ti–Zr). (auth)

Plasma and Thermonuclear Physics

Refer also to abstract 53416.

52763 (A/CONF.49/P–377) STATUS OF CONTROLLED THERMONUCLEAR RESEARCH IN THE FEDERAL REPUBLIC. **Schlueter, A. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Apr 1971. 8p. (CONF-710901–130). Dep. NTIS (U. S. Sales Only).**

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Since the attainment of thermonuclear temperatures has been proved feasible by fast magnetic compression in straight geometry, the application of this method to toroidal configurations of the screw pinch type and of types intermediate between (high β) stellarator and M + S has shown promising results. At KFA, the emphasis is placed on large aspect ratios; at IPP, besides smaller experiments, the fast 2.6-MJ capacitor bank feeds a relatively slender torus of 3-m diameter. Long-time stable toroidal con-

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finement was achieved with contact-ionized and with photo-ionized plasmas in the (low β) Wendelstein stellarator. Ohmic heating and possibly high frequency heating will permit higher temperatures and higher pressures. The construction of a large superconducting Wendelstein stellarator will increase the range of parameters. Parallel investigations in the Pulsator tokamak should help in the interpretation of the results obtained in either configuration. All this work as well as a large amount of additional investigations is intended to establish the feasibility of a prototype fusion reactor of the toroidal type. The important problems of the "first wall," i.e., the solid state/plasma interface, have been studied mainly at IPP, while at KFA increasing effort is being expended on the technological problems of the reactor, including the neutronics of its blanket. (auth)

52764 (A/CONF.49/P-441) THERMONUCLEAR RESEARCH IN THE USSR. Artsimovich, L. A. (State Atomic Energy Committee, USSR). Jun 1971. 35p. (CONF-710901-383). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The following main trends and engineering developments carried out in the USSR are discussed: (1) study of methods to produce a high-temperature plasma in closed magnetic systems; (2) production of a high-temperature plasma in traps with magnetic mirrors; (3) production of a high-ion-temperature dense plasma by means of obtaining a "plasma focus;" and (4) study of the processes of the plasma—high-frequency field interaction to develop methods for plasma heating and plasma instability suppression. (M.O.W.)

52765 (A/CONF.49/P-813) RESEARCH ON CONTROLLED THERMONUCLEAR FUSION IN THE COMMISSARIAT A L'ENERGIE ATOMIQUE. Trocheris, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires); Lidin, G. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Apr 1971. 16p. (In French). (CONF-710901-339). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Research work is summarized on controlled thermonuclear fusion conducted in the Commissariat à l'Energie Atomique with two approaches: low densities associated with long confinement times and very high densities achieved during a very short time. The first approach consists essentially in studying plasma confinement in various magnetic configurations which may be open or closed. In the field of open configurations the results obtained from two experiments on confinement by static magnetic mirrors are reported. A brief account is also given of the experimental and theoretical results obtained so far on a concept of mixed confinement using both static magnetic mirrors and high-frequency plugs, and preliminary conclusions are presented on the possibility of using this concept in a thermonuclear reactor. In the field of closed configurations the theoretical work on equilibrium and stability of toroidal plasmas is summarized, together with the experimental results on the equilibrium of plasma rings of noncircular shape. The experiments on hard-core configurations are also briefly described in relation to the influence of shear on plasma stability and diffusion. An alternative approach to research on controlled fusion consists in considering very dense plasmas (energy density greater than 10^{10} erg/cm^3) obtained by transferring a large amount of energy to matter in a very short time. This can be achieved in the plasma focus by means of a fast discharge. The result is a temperature of about 10^7 °K for a density of 10^{19}/cm^3 and 10^{11} neutrons per shot with D—D. An alternative energy source is the laser beam delivering 100 J of which 70 are transferred to the plasma. The temperatures exceed 10^7 °K and a few times 10^4 neutrons are emitted. (auth)

52766 PLASMA PHYSICS INDEX. VOLUME 6, NO. 6, 1971. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 155p.

This listing includes 573 references on various aspects of plasma physics. (M.O.W.)

52767 PLASMA PHYSICS INDEX. VOLUME 6, NO. 7, 1971. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 148p.

This listing includes 482 references on various aspects of plasma physics. (M.O.W.)

52768 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. VOLUME 5, NO. 6, 1971. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 53p.

This listing includes 278 references on various aspects of controlled thermonuclear research. (M.O.W.)

52769 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. VOLUME 5, NO. 5, 1971. Bibliography, Author Index, Subject Index, Appendix. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 50p.

This listing contains 256 references on various aspects of controlled thermonuclear research. (M.O.W.)

52770 PRESENT STATUS AND OUTLOOK OF DEVELOPMENTS IN PLASMA PHYSICS AND CONTROLLED THERMONUCLEAR FUSION. Tolok, V. T. Visn. Akad. Nauk Ukr. RSR; No. 10, 25-30(Oct 1970). (In Ukrainian).

The development work carried out during the last 12 years at the Kharkov Physico-Technical Institute is outlined. Three distinct stages may be noted in the history of plasma physics and thermonuclear fusion studies of this period. The first period, from 1957 to 1960, is characterized by the creation of a strong Plasma Physics Division under the leadership of K. D. Sidelnikov. The work during 1960 to 1967 had a strong "controlled thermonuclear" orientation and reflected the influence of I. V. Kurchatov. During these years, high-frequency heating of plasma, ion-cyclotron waves, turbulent streams, and beam instabilities were studied. The thermonuclear devices Uragan I and Sirius, the largest stellarator, were built during these years. Interest in thermonuclear fusion studies was maintained during the third or current period. In addition to new experimental devices, strong theoretical investigations were carried out under the guidance of O. I. Akhiezev. Creation of a strong plasma physics research collective is considered the main achievement of these 12 years. The team is quite youthful, with an average age of about 30 years. It completed 9 doctoral and 50 candidate-level dissertations, in close cooperation with the University of Kharkov. (TTT)

Confinement and Heating

52771 (KHFTI-70-62) STUDY OF THE TURBULENCE AND HEATING OF A PLASMA WITH A TRANSVERSE CURRENT. Demchenko, V. V.; Sizonenko, V. L.; Stepanov, K. N. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

The conditions of turbulent pulses of density, velocity of electrons and ions, and of the intensity of the electric field in a plasma was investigated, when a current is flowing perpendicular to the magnetic field. A hydrodynamic cluster instability with a given frequency and increment of buildup is developed. The cross section of combined scattering of microwaves by electron density pulses was evaluated, and a comparison was made with the experimental results. It was shown that, in such a plasma, there is an effective heating mechanism for the nonresonance ions associated with the final correlation time of electric field pulses. The increases of the transverse ion temperature and longitudinal electron temperature were determined. Heating is contingent on the Larmor ion radius being less than the chamber radius. (tr-auth)

52772 (NP-18973) STUDY OF PLASMA CONTAINMENT IN TOR-1 STELLARATOR. Anulina, D. K.; Andryukhina, E. D.; Nechaev, Yu. I.; Fedyanin, O. I.; Khol'nov, Yu. V. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Jun 1971. 27p. (In Russian). Dep. NTIS (U. S. Sales Only).

Experiments were run to study plasma containment at high and low collision frequencies on the same equipment. The plasma was created by two methods: first by external injection from an arc source at $n = 5 \times 10^{10}$ cm^{-3} and T_e = about 1 to 2 eV, and secondly, by ionization and heating by means of a very-high-frequency electromagnetic field with $n = 2 \times 10^{12}$ cm^{-3} and T_e = about 0.2 to 0.4 MeV. The structure of the magnetic field was investigated, and found to be perfect. Hence it was possible to determine the plasma lifetime in a collision-free regime over a large range of rotational transform angles (up to 3π). A linear increase in plasma lifetime is observed even at large transform angles. From an accurate knowledge of the magnetic field structure and the carrying out of experiments on studying the effect of resonance perturbations on plasma containment, it is possible to state that the change in the diffusion dimension is not determined in decreasing the plasma lifetime for resonance values of angles of rotational transform. On obtaining a plasma by high-frequency ionization it was found that there is an anomalous, nonresistive absorption of energy on interaction of the high-frequency waves with the plasma. The anomalous absorption is accompanied by the appearance of a quasi-stationary constant current flowing through the plasma. The plasma parameters obtained by high-frequency ionization were $n = 5 \times 10^{12}$ cm^{-3} and $T_e = 3$ to 8 eV. The conditions of plasma creation significantly determine the behavior of the decaying plasma. Studies of the characteristics of containing a dense plasma showed that the containment time was of the same order of magnitude as would be expected from the theory of hydrodynamic equilibrium in toroidal systems. (TTT)

52773 EFFECT OF NONLINEAR PROCESSES ON PLASMA HEATING IN MAGNETO-ACOUSTIC RESONANCE. Vaclavik, J. (Univ., Fribourg, Switzerland). Helv. Phys. Acta; 44: No. 3, 359-66(15 May 1971).

In magneto-acoustic resonance, the effect of nonlinear processes on the temperature increase of a dense collision-dominated plasma is investigated. It is shown that the nonlinear processes diminish the theoretical value of the temperature increase even for very small amplitudes of the excited waves. (auth)

52774 DIFFUSION MEASUREMENT IN AN AXIALLY DECAYING MAGNETIZED PLASMA WITH OSCILLATIONS. Kando, Masashi; Takeda, Susumu (Nagayo Univ., Japan). J. Phys. Soc. Jap.; 31: No. 3, 919-24(Sep 1971).

The theory of the diffusion wave in magnetized plasmas proposed by Golubev is extended to include wide ranges of pressure and magnetic field. The wave of 2 kHz is excited at the tube end by modulating the hf amplitude, which produces an axially decaying plasma in a He gas at the pressure of 80 mtorr. The diffusion coefficients parallel and perpendicular to the magnetic field are calculated from the measured phase constant of the excited wave and the density decaying length; they agree fairly well with the ambipolar values, insofar as the noise level is relatively low. The oscillation has almost a constant frequency of a few kHz in the magnetic field higher than 320 G. It is found that the oscillation results from a helical-type instability. (auth)

52775 NATURE OF TURBULENT HEATING IN THE TOKAMAK TM-3 DEVICE. Rudakov, L. I. Zh. Eksp. Teor. Fiz.; 60: No. 6, 2134-41(Jun 1971). (In Russian).

An explanation of the experimental data obtained earlier is proposed which is based on the theory of anomalous resistance arising as a result of ion-acoustic current instability in a plasma. In a strong magnetic field the anomalous resistance may be due to instability of short-wave oscillations, for which $kv_{Te}/\omega_{He} > 1$. The laws of turbulent ion and electron heating are explained. It is shown on the basis of the experimental data that the characteristic time for hot-ion escape is defined by "classical" diffusion due to scattering by electric field fluctuations. It is predicted that, because of overheating instability, the current should flow along thin filaments in which the heat is evolved. In this case the experimental data can be made consistent with the "classical" losses. (auth)

52776 PARAMETRIC DEPENDENCE OF THE DENSITY IN A MIRROR-CONFINED PLASMA SUBJECT TO AN ION-CYCLOTRON INSTABILITY. Foote, James H. (Univ. of California, Livermore). Phys. Fluids; 14: No. 10, 2242-4 (Oct 1971).

A relation is derived predicting a $\tau_{cx}^{3/5} B^{16/5} W_i^{-1}$ variation of ion density for onset of an ion-cyclotron instability in a mirror-confined plasma. This threshold behavior may explain why no complete density limitation has been observed in strongly unstable plasmas of two relevant experiments. (auth)

52777 DRIFT EFFECTS ON THE BEHAVIOR OF A LOW-β AXISYMMETRIC TOROIDAL PLASMA. Bowers, E.; Winsor, N. K. (Princeton Univ., N. J.). Phys. Fluids; 14: No. 10, 2203-16(Oct 1971).

Analysis of a low-β axisymmetric toroidal plasma is reported. This predicts shock structure in the presence of resistivity and viscosity. A one-fluid model is considered which includes the Hall terms in Ohm's law and gyroviscous corrections to the pressure tensor. In analyzing this behavior two orderings are used. For typical stellarator parameters, the first ordering (in which the mean free path is less than the connection length but greater than a critical value) leads to a stable rotational equilibrium with a positive potential on axis. In the second ordering the mean free path is less than this critical value and a shock develops toward the inside of the torus, leading to diffusion an order of magnitude larger than the Pfirsch–Schlueter value. A Korteweg–de Vries equation with an added dissipation term due to parallel viscosity, governs the azimuthal density variation in the shock region. Agreement is found between theory and the results of a two-dimensional computer simulation of a toroidal plasma. (auth)

52778 DIFFUSION OF AN EQUILIBRIUM TOROIDAL PLASMA AT INTERMEDIATE AND HIGHER COLLISION FREQUENCIES. Connor, J. W.; Stringer, T. E. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids; 14: No. 10, 2184-92(Oct 1971).

An expression for the equilibrium diffusion rate is derived using the generalized equations previously published. Different limiting forms of this expression are compared with the intermediate collisional and highly collisional results derived earlier. The validity of these results are found to be more restricted than previously assumed. To cover the range of experimental interest, two new limiting conditions are considered. In both these the ambipolar diffusion is generally comparable to the Pfirsch–Schlueter rate. The generalized expression allows the diffusion to be evaluated in the transition zones between the different regimes. (auth)

52779 HIGH-FREQUENCY PLASMA CONFINEMENT. Demchenko, V. V.; Hussein, A. M. (Atomic Energy Establishment, Cairo). Phys. Lett.; 36A: No. 4, 291-2(13 Sep 1971).

The effect of high-frequency pressure of externally induced fields on plasma density distribution in bounded systems is considered. The high-frequency pressure is shown to contribute to plasma confinement in bounded systems. (auth)

52780 PLASMA HEATING BY TWO HIGH-FREQUENCY WAVES BEATING IN GYRORESONANCE. Crescentini, A. Airoldi; Orefice, A.; Pozzoli, R. (CNR, Milan). Phys. Lett.; 36A: No. 4, 331-2(13 Sep 1971).

The energy gain of plasma particles interacting with two traveling electromagnetic waves beating near the gyrofrequency is investigated by solving numerically the exact equations of motion. An insight in the nonlinear interaction is given by means of a suitable schematization. (auth)

Diagnostics

Refer also to abstract 52834.

52781 (AD–720856) TEMPERATURE MEASUREMENTS OF Ar PLASMA ARCS AND PRELIMINARY F-VALUE MEASUREMENTS OF LYMAN BETA, GAMMA, AND DELTA. Ogawa, Shizuko; Weissler, G. L. (University of Southern California, Los Angeles. Dept. of Physics). Dec 1970. Contract F33615-68-C-1228. 38p. (USC-VacUV–122; ARL–70-286). NTIS.

A wall-stabilized arc is investigated spectroscopically in both the visible and the vacuum-ultraviolet regions. The plasma temperature is studied as a function of pressure and deviations from local thermal equilibrium are observed. Preliminary measurements were made of f-values of the hydrogen resonance lines Lyman-beta, -gamma, and -delta. Finally, it is shown that the arc can also be operated in helium. (auth) (USGRDR)

52782 (IPP-1/117) SIDE-ON INTERFEROMETRY AT WAVE LENGTH 10.6 μm IN THETA-PINCH PLASMAS. Daerr, A.; Decker, G.; Roehr, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). May 1971. 26p. (In German). Dep. NTIS (U. S. Sales Only).

An experiment for measuring spatially resolved electron density by interferometry at 10.6 μ is described. The experiment was performed on a theta-pinch plasma. The intention was to prove the feasibility of this technique for use on toroidal pinches. A transverse pumped CO_2 laser of some MW power served as the radiation source. A Mach–Zehnder interferometer was chosen. An area detector of simple construction was developed and used to make the interference fringes visible. In order to make the discharge vessel (quartz) transparent for the 10.6-μ radiation, BaF_2 glass windows (Schott: IR6 13) were inserted. The sensitivity of this technique is 1 to 2×10^{15} cm^{-2}. Some examples of measured density profiles show that this method may be used very effectively on toroidal plasma machines. (auth)

52783 INSTRUMENT FOR SCANNING SPECTRAL LINES FROM PLASMAS. Cremers, C. J.; White, J. E. (Univ. of Kentucky, Lexington). pp 668.1-8 of Proceedings of the 24th Annual ISA Conference. Pittsburgh; Instrument Society of America (1969).

From twenty-fourth annual conference of Instrument Society of America; Houston, Tex. (27 Oct 1969). See CONF-691004–(Pt.4).

A simple solution to the problem of rapid measurement of longitudinal spectral-line intensity distributions is described. These measurements are necessary for the determination of plasma temperatures by remote scanning using a spectrometer. A Bausch and Lomb two-meter dual-grating spectrograph has the dispersion desired for such measurements and, because of a unique feature in its construction, it can be readily modified for rapid line scanning in the longitudinal direction. One of the two gratings is removed and the other, which is fixed to a flexible mount, is replaced by a double-size grating. A simple drive mechanism is mounted on top of the spectrograph and is linked to an extension of the grating mount. The drive rotates the grating through a small angle about an axis parallel to the face of the grating and perpendicular to the direction of ruling. The slight rotation of the grating causes the spectrum at the spectrograph exit to move uniformly in the direction of the line length. Fixed photomultipliers can then be used to

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record the intensity profiles of as many lines as desired. The external drive mechanism is linear and can easily be operated to give line scans in fractions of a second if desired. These systems are described in detail. In addition, the output electronics is described, along with a brief outline of the data analysis leading to plasma temperatures. (auth)

52784 EFFECT OF A SLIT ON THE MEASURED PLASMA ION-ENERGY DISTRIBUTION. Stallings, Charles H.; Kuswa, Glenn W. (Univ. of Wisconsin, Madison). J. Appl. Phys.; 42: No. 10, 3960-4(Sep 1971).

Measured ion-energy distributions were found to vary with the width of the slit separating the body of a streaming plasma from the analyzing system. Slit widths from 0.1 to 75 Debye lengths were investigated. The flux of ions detected on centerline and at a given energy varied linearly with (W − l) for W sufficiently large. W is the width of the slit and l is a positive number independent of W but depending on the plasma parameters. Using this linearity the ion-energy distribution in the plasma could be extracted from two measurements of the distribution at different slit widths. An analysis of the effect predicted the variation of ion flux with slit width as a function of plasma parameters. This analysis gave a method for determining Debye length and electron temperature as well as the correct ion-energy distribution from measurements of the ion flux. (auth)

52785 ELECTRON-DENSITY AND ELECTRON-TEMPERATURE MEASUREMENTS IN BOUNDARY LAYERS. Dunn, Michael G. (Cornell Aeronautical Lab., Inc., Buffalo). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 8, 1561-7(Aug 1971).

Thin-wire Langmuir probes were used to measure the electron-density and electron-temperature distributions in the nozzle-wall boundary layer of a hypersonic shock tunnel and in the boundary layer of a sharp flat plate located on the nozzle centerline. Experiments were performed in a nozzle-wall boundary layer, with nitrogen as the test gas, in order to obtain a comparison between the results obtained with voltage-swept probes aligned with the flow and constant bias-voltage probes perpendicular to the flow direction. These measurements were performed in the boundary-layer flow because that is the flow environment in which the constant-voltage probes were to be used in flight applications. Only voltage-swept probes aligned with the flow were performed in preparation for antenna admittance measurements to be made in the future. These experiments were conducted in a test gas composed of argon plus 0.12% nitrogen. The flow conditions for both experiments were such that free-molecular flow theories could be used to infer ion densities from the ion-current portion of the probe characteristics. Electron temperatures measured in these boundary layers were found to be substantially greater than the calculated heavy-particle translational temperature at the boundary-layer edge. For the flat-plate experiments, the electron temperature remained relatively constant through the boundary layer and along the plate. However, the electron temperature in the nozzle-wall boundary layer decreased from the outer-flow value as the wall was approached. The positive ion-density distributions obtained in this latter boundary layer using the two probing techniques (aligned with and perpendicular to the flow) were found to be in good agreement. In addition, the calculated boundary-layer thickness was found to approximate the distance from the wall at which the measured electron density approached a constant value. (auth)

52786 EXPERIMENTS ON LASER AND MICROWAVE PLASMA PROBING AND MEASUREMENTS OF THE DIAMAGNETIC EFFECT WITH THE TOKAMAK T-3a DEVICE. Anashin, A. M.; Gorbunov, E. P.; Ivanov, D. P.; (and others). Zh. Eksp. Teor. Fiz.; 60: No. 6, 2092-2104(Jun 1971). (In Russian).

The plasma electron temperature in the tokamak T-3a device was determined on the basis of Thomson scattering in conjunction with electric, microwave, corpuscular, and diamagnetic measurements. The measurements were performed at plasma concentrations between 10^{13} and 4×10^{13} cm^{-3}, discharge currents of 40 to 130 kA and stabilizing field strengths in the 17- to 38-kOe range. It is shown that, for the majority of plasma electrons, the energy distribution is approximately Maxwellian with a temperature between 0.5 and 2 keV. Stationary temperatures are attained during the process (35 msec). The plasma density determined by measuring the absolute intensity of scattered laser light is close to that found by microwave interferometer measurements. Radial distributions of temperature, electron density, and pressure of the electron component are found for various discharge stages. The density distributions measured with a laser and multichannel microwave interferometer are identical. The transverse plasma energy derived from diamagnetic measurements satisfactorily agrees with that calculated on basis of laser, microwave, and corpuscular measurements. The electron temperature increases with increase of current and decrease of density and is practically independent of the stabilizing field strength. At the moment corresponding to maximal energy storage in the plasma, the value of $\beta_J = 8\pi\bar{p}/H_J^2$ is 0.4 ± 0.1 and at the end of the process exceeds unity. Both the radial distribution of electron temperature as well as energy balance in the plasma electron component may be explained by an anomalous electron thermal conductivity. The lifetime of the plasma particles derived from H_α measurements exceeds the energy confinement time by at least several times. The degree of anomalousness of the plasma resistance rapidly grows with growth of ratio of drift velocity to ion-sound velocity. (auth)

52787 ELECTRONIC METHOD FOR DIRECT DISPLAY OF ELECTRON ENERGY DISTRIBUTIONS IN PLASMA. Sicha, M.; Rezacova, V.; Tichy, M. (Charles Univ., Prague). Czech. J. Phys.; 21: No. 7, 794-8(1971).

Direct display of the electron energy distribution function was performed with the aid of the analog computer MEDA 41 TA. (auth)

52788 DIAGNOSTICS OF PLASMA ACCORDING TO BROADENING OF SPECTRAL LINES IN INHOMOGENEOUS INTERATOMIC ELECTRIC FIELDS. Grechikhin, L. I. Zh. Prikl. Spektrosk.; 11: No. 2, 221-6(Aug 1969). (In Russian).

The broadening of spectral lines under the effect of inhomogeneous interatomic electric fields was examined; it was found that their essential effect occurs for the lower excited levels of complex atoms. The method of isolation of pure broadening is proposed, utilizing multiplets at which the upper level is the same and lower levels different; the isolation is provided by the fact that one of the lower levels must not be subjected to the effect of the inhomogeneous interatomic electric field. The conditions for and limits of the applicability of the method are analyzed. (tr-auth)

52789 HIGH-SPEED PHOTOGRAPHING OF FAST THETA-PINCH PLASMA INCLUDING A REVERSE MAGNETIC FIELD. Ishii, Shozo; Hayashi, Izumi; Senoo, Yoshibumi; Hashimoto, Hiroyuki (Tokyo Inst. of Tech.). Kakuyugo Kenkyu; 26: No. 1, 14-23(Jan 1971). (In Japanese).

Effects on macroscopic behavior of fast theta-pinch plasma due to direction and intensity of a magnetic field contained in a plasma cylinder were investigated with an image-converter camera. A fast theta-pinch plasma generator with 1.56 Wb/m^2 of maximum flux density, 12 μF of total capacity of condenser bank and 25.2 kV of charging voltage was employed for the study. Measurement with a magnetic probe was also carried out. The theta coil was a translucent coil with many slits so that phenomena along the axis could be observed. Three dimensional observation was performed with a reflector. When a strong reverse magnetic field was confined, area waves transmitting from end of the coil to the center were produced, and its velocity was about 5 cm/μsec, being in agreement with theory. The waves collided at the center of the coil, and the plasma came into violent contact with the wall of a discharge tube. Disappearance of the reverse magnetic field was not seen, however. It was found that phenomena along lines of magnetic force could not be disregarded in the case of a linear theta pinch. (Japan)

52790 NONISOTHERMAL THEORY OF AN ELECTROSTATIC PROBE IN A WEAKLY IONIZED GAS. Jou, Wen-huei; Cheng, Sin-i (Princeton Univ., N. J.). Phys. Fluids; 14: No. 10, 2144-51(Oct 1971).

The isothermal assumption for electrons is removed from the continuum theory of the electrostatic probe. Asymptotic analyses based upon small Debye length are developed for both cold and warm ions with an appropriate electron energy equation. The structure of the asymptotic expansion is essentially changed from that of the isothermal theory. In particular, the current–voltage characteristic is expressed as a series in which the leading term, obtained under quasi-neutral approximation, is of the order of unity and the subsequent terms are small in the asymptotic sense. The results may be used to explain the discrepancies between the isothermal theory and some experimental results of Little and Waymouth. (auth)

52791 PROCESS TO DETERMINE THE CONCENTRATION OF AN ELEMENT ADDED IN VAPOR STATE TO A PLASMA. (to N. V. Philips Gloeilampenfabrieken). French Patent 1,571,058. 5 May 1969. Priority date 22 Jun 1967, Netherlands. (In French).

In the process described, the gaseous element (the concentration of which is to be determined) is added to a low-pressure plasma, through which a beam of electromagnetic radiation is directed. From the absorption of this beam the concentration of the element is found. (J.F.P.)

52792 SCATTERING DIAGNOSTICS OF PLASMA BY CO_2 LASER. Yokoyama, M. (Osaka Univ.); Nakatsuka, M.; Yamanaka, C.; Izawa, Y.; Toyoda, K. Phys. Lett.; 36A: No. 4, 317-18 (13 Sep 1971).

By using 10.6-μ infrared CO_2 laser radiation, electron density measurement of steady TP-D plasma was carried out with forward ($\theta = 30°$) and backward ($\theta = 171°$) scattering and interferometry methods. Electron densities measured by both methods as a function of discharge current of TP-D plasma show fairly good agreement. (auth)

Kinetics (General)

Refer also to abstract 52598.

52793 (KHFTI-70-50) INTERACTION OF PLASMA STREAMS WITH STATIONARY, AXIALLY SYMMETRIC MAGNETIC FIELDS. Azovskii, Yu. S.; Guzhovskii, I. T.; Khizhnyak, N. A. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 76p. (In Russian). Dep. NTIS (U. S. Sales Only).

The interaction of moving plasma and plasma clusters with axially symmetric external magnetic fields was studied experimentally and theoretically within the framework of a general program on plasma injection and magnetic traps. A "small, compressible plasma" model was used as the basis of the theoretical examination, taking into account deformation, induced azimuthal current, heating, and electrical polarization of the plasma during the interaction. The magnetohydrodynamic approximation was used to examine the Hall current. Interactions with magnetic fields were experimentally studied with the fields of a solenoid, a short winding, two windings, and also with the field exhibiting spatial periodicity. The experimental study involved the determination of the basic parameters of the plasma stream such as density, radius, temperature, induced current, and electric field of polarization. Comparison of the experimental and theoretical results revealed that the chosen model describes the interaction qualitatively and, in some cases, even quantitatively. The data obtained are of interest for the design of magnetic traps and for the acceleration of large currents of charged heavy particles. (TTT)

52794 FUNDAMENTALS OF GASEOUS IONIZATION AND PLASMA ELECTRONICS. Nasser, Essam. Wiley Series in Plasma Physics. New York; John Wiley and Sons, Inc. (1971). 468p. $19.95.

The following chapters are included: (1) theory of gases, (2) atomic structure, (3) ionization, (4) deionization, (5) electron emission, (6) behavior of charged particles in a gas in electric fields of low E/p, (7) behavior of charged particles in a gas in electric fields of high E/p, (8) self-sustaining discharge, (9) breakdown mechanisms, (10) temporal development of breakdown, (11) partial breakdown of coronas, (12) breakdown under alternating fields, (13) the glow, and (14) plasmas. (M.O.W.)

52795 TRANSVERSE MAGNETIC FIELD EFFECTS ON A CROSS-FLOW ARC. Benenson, David M.; Baker, A. J. (Univ. of New York, Buffalo). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 8, 1441-6(Aug 1971).

Experiments were conducted upon an 80-A, 1.1-atm argon crossflow arc in a constant velocity mainstream flow of 182.8 cm/sec; electrode spacing was held constant at 6.3 mm. Applied transverse magnetic fields ranged from the zero-balanced mode (B = 0) to the balanced configuration (B = 11.2 gauss). Isotherm distributions were obtained in several horizontal planes; cross-sectional shapes and profiles were thereby inferred. The arc cross-sectional shape was found to be noncircular in all cases. For the zero-balanced mode, the major axis of the cross-sectional shape was in the direction of flow; for the balanced configuration, the major axis was in the direction transverse to the flow. The experimental results indicated that the influence of the magnetic field was perceived throughout the plasma. For the zero-balanced mode, the effects of forced convection were found principally in the outer region; the inner core was approximately circular in cross section. (auth)

52796 ELECTROLYTIC CAPACITOR CURRENT PULSE NETWORKS FOR QUASI-STEADY MPD ARCS. Wilbur, Paul J. (Colorado State Univ., Fort Collins). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 8, 1447-51(Aug 1971).

A simple model of an equal element LC ladder network containing electrolytic capacitors as the energy storage components is presented, and the current waveform predicted by the model for the case of the network discharging through a fixed inductive-resistive load is shown to agree with an experimentally observed waveform. The effect of the series resistance associated with electrolytic capacitors on the efficiency of energy transfer from the network to the load is determined. Using these results, the mass of a power source-pulse network system containing electrolytic capacitors is compared to that of a system which contains nonelectrolytic units and transfers the same power to a quasi-steady MPD arc load. Results of this comparison based on a state-of-the-art component specific masses indicate electrolytic systems are less massive than conventional systems, particularly at low power, long pulse duration conditions. (auth)

52797 DIFFUSION OF STRONGLY IONIZED THERMAL PLASMAS IN A MAGNETIC FIELD. II. RESULTS OF MEASUREMENTS. Fuchs, G. (Univ., Marburg, Ger.). Ann. Phys. (Leipzig); 26: No. 2, 157-65(1971). (In German).

A thermal cs plasma was produced by contact ionization at the surface of a hot tungsten helix spanned in the axis of a cylindrical glass vessel. The plasma density profile n(r,z) as a function of a magnetic field in the z-direction was measured with a movable Langmuir probe. The measured profiles are compared to the calculated ones. From this comparison the cross section for collisions with the neutrals are calculated. Furthermore, the measurements show that diffusion perpendicular to the magnetic field takes place "classically". (auth)

52798 PROPAGATION OF MICROWAVE DISCHARGE OF HIGH PRESSURE. Raizer, Yu. P. (Inst. of Mechanical Problems, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 1, 222-34(Jul 1971). (In Russian).

Propagation of microwave discharges in gases at pressures of the order of one atmosphere is considered. Thermal conductivity is the major mechanism of propagation of the discharge toward the incident electromagnetic wave. Heat from the plasma is transmitted to the cold gas, which becomes heated and ionized and begins to absorb microwave radiation. The problem of stationary conditions of propagation of a discharge wave is formulated and solved approximately. The temperature up to which the plasma can be heated and the velocity of the discharge front as a function of energy flux in the electromagnetic wave, as well as the threshold for existence of the conditions are determined. It is shown that the process has much in common with combustion. The phenomenon is not infrequently observed in microwave continuously operating devices when a discharge is ignited in the waveguide and the plasma formation moves toward the microwave source. However, up to now, no physical interpretation of the phenomenon has been offered. Reasonable agreement between the calculation results and experimental data is obtained. (auth)

52799 ISOMAGNETIC DISCONTINUITY IN A COLLISONLESS SHOCK WAVE. Eselevich, V. G.; Es'kov, A. G.; Kurtmullaev, R. Kh.; Malyutin, A. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 60: No. 6, 2079-91(Jun 1971). (In Russian).

Results are presented of an investigation of the microstructure of a collisionless shock front. The investigation was performed by means of special probes with high spatial resolution. It was found that at Mach numbers exceeding a certain critical value, $M_{c1} \approx 2.8$ to 3, a narrow region is formed in the transition layer. In a practically stationary magnetic field the potential experiences a sharp jump (isomagnetic discontinuity) in this region. The width of the region δ is apparently of the order of several Debye radii r_D. Further increase of the Mach number leads to the disappearance of the discontinuity at $M = M_{c2} \sim 4.5$ to 5.5. It is suggested that appearance of the isomagnetic jump is associated with formation of an electrostatic ion-acoustic wave in the transition layer. The cause of this phenomenon is nonlinear slope increase which cannot be compensated by dissipative front broadening at $M > M_{c1}$. Disappearance of the jump at $M \approx M_{c2}$ is apparently due to reflection of part of ions by the front and is similar to destruction of a strong electrostatic wave at large Mach numbers. Destruction of the isomagnetic discontinuity accompanied by formation of a multiple-velocity plasma flow can be naturally interpreted as an overturning of the shock wave. (auth)

52800 INVESTIGATION OF NEUTRAL DRAG INSTABILITY IN AN ARC DISCHARGE. Ekdahl, Carl August Jr. San Diego, Calif.; Univ. of California (1971). 222p. University Microfilms Order No. 71-20,105.

Thesis.

In order to investigate the mechanism responsible for instabilities that have been observed in magnetoplasmadynamic (MPD) arcs, a pulsed hot-cathode MPD arc was modified by extending the cylindrical anode and replacing the diverging axial magnetic

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bias field with a uniform axial field in the arc region. This device was operated in an argon atmosphere in the pressure range of 3 to 150-μ Hg in lieu of using a propellant gas mass flow through the discharge region. The external current and voltage characteristics of this arc are quite typical of those observed in experiments with more conventional MPD arcs. Investigation of the discharge with Langmuir probes and optical techniques showed that the arc was unstable to an $m = 1$ mode of disturbance. The onset of the instability occurred if the bias field was increased above a reproducible critical field which varied between 0.1 and 0.8 kG according to the neutral density and arc power level. The nature of this variation of the critical field strongly resembles that observed in more-conventional MPD arcs. The functional dependence of the rotation frequency on the bias field, arc current, and background pressure is also typical of observations made of the current spoke instability in MPD arcs. Maps of the plasma density and floating potential were obtained in both the quiescent ($m = 0$) and spoked ($m = 1$) modes of the discharge. The plasma streaming velocity was determined using negatively biased double plane Langmuir probes, and the ion saturation current probe measurement of the plasma density was corrected to take into account this streaming. The electron temperature was measured spectroscopically at several radii by ratioing the intensities of sixteen argon II spectral lines. The Simon–Hoh linearized theory of the neutral drag ($E \times B$) instability was developed in cylindrical coordinates, and was extended to take into account Coulomb collisions between charged particles. The theoretical model of the quiescent mode was used in conjunction with the experimental observations to provide a basis for the perturbation stability analysis. It was found that this approach yielded a theoretical result for the critical bias field that agreed quite well with the experimentally determined critical field. (Diss. Abstr. Int., B)

52801 SHOCK OBSERVATIONS IN A CONTINUOUS SUPERSONIC PLASMA WIND TUNNEL. **Bartoli, C.; Bitter, M.** (ESRO, Frascati, Italy). Nuovo Cim.; 5B: No. 1, 95-109(11 Sep 1971).

A Q device modified into a magnetic de Laval nozzle is described. Experimental results on a supersonic plasma flow striking a material object are compared with those of a simple adiabatic theory. Suggestions are added for improvements of the experimental setup. (auth)

52802 SINGLE-PARTICLE RADIATION NEAR ELECTRON CYCLOTRON HARMONICS. **Crosignani, E.** (Laboratorio di Fisica del Plasma ed Elettronica Quantistica, Pavia, Italy. Univ., Pavia, Italy); **Siragusa, G.; Zambotti, G.** Nuovo Cim.; 5B: No. 1, 83-94(11 Sep 1971).

The single-particle component of the radiation spectrum of a positive column in a magnetic field near the electron cyclotron harmonics is studied both experimentally and theoretically. The microwaves from the plasma were collected by means of different cavities resonating on various modes. Thus, it was possible to show that the single-particle radiation originates mainly from the sheath. In the theoretical calculation, the intensities were predicted on the basis of the Bickerton and von Engel model of the sheath and under the assumption that, over an electron orbit, the electric field could be approximated by constant plus linear plus quadratic terms. One finds a good quantitative agreement between the experimental and theoretical results insofar as the intensities of the harmonics are concerned, while the average frequencies of the lines turn out to be slightly different. (auth)

52803 MEASUREMENTS ON A MAGNETOHYDRODYNAMIC SHOCK. **Sommer, E. J. Jr.; Barach, J. P.** (Vanderbilt Univ., Nashville). Phys. Fluids; 14: No. 10, 2102-6(Oct 1971).

An electrically driven shock wave is launched axially down a tube filled with $T_e = 1$- to 2-eV plasma, carrying an axial current and associated azimuthal magnetic field (250 G). The number density is between 10^{16} and 10^{17} cm^{-3} and the shock Mach numbers range from 1.2 to 6.5. Flux compression of 10 to 25% at the front is observed, but this amount is very much smaller than ideal theory predicts and its duration is briefer. The flux increase is closely followed by diamagnetic discharge plasma producing an abrupt flux decrease. Mixing with this plasma and boundary-layer flow to the walls of the shock tube account for the small and brief field compression observed. Rough calculations support this picture and include an effective fraction q_1 of the flow not undergoing compression. This q_1 is found to be as high as 50%. (auth)

Kinetics (Experimental)

Refer also to abstract 52857.

52804 MEASUREMENTS OF COLLISIONAL-EXCITATION-RATE COEFFICIENTS FOR BERYLLIUM-LIKE IONS. **Johnston III, W. D.; Kunze, H. -J.** (Univ. of Maryland, College Park). Phys. Rev., A; 4: No. 3, 962-70(Sep 1971).

Rate coefficients for excitation by electron collisions were determined experimentally for excited singlet and triplet ($n = 2$, 3, and 4) levels of the beryllium-like ions N(IV), O(V), Ne(VII), and Si(IX) using various plasma cases produced in a θ-pinch device. Line intensities of these ions were measured absolutely and converted into rate coefficients by knowledge of the pertinent plasma parameters. Electron density and temperature were obtained as functions of radius and time from the spectrum of scattered laser light. The intercombination transition $2s2p\,^3P \rightarrow 2s^2\,^1S$ was observed, and its absolute intensity allowed determining the metastable triplet-level population. The probable error of any individual rate coefficient is estimated to be a factor of 2. (auth)

52805 ELECTROMAGNETIC SHOCK WAVE IN A CURRENT-CARRYING MEDIUM. **Sommer, Edward James Jr.** Nashville; Vanderbilt Univ. (1971). 92p. University Microfilms Order No. 71-20,311.

Thesis.

A shock wave (Mach 1.2 to Mach 6.5) propagating through a current-carrying plasma of known initial conditions ($T_e \simeq 1.2$ eV, $n_e \simeq 10^{16}$ cm^{-3}; $T_e \simeq 2.1$ eV, $n_e \simeq 10^{17}$ cm^{-3}) is investigated. The shock wave is produced in a conical electrode electromagnetic shock tube and travels through a preheated argon test gas which is threaded by an azimuthal magnetic field derived from an axially directed preheating current. Observations of the magnetic field profile across the shock system show a brief field compression followed by a field decrease to below the ambient value. The magnitude of the field compression is lower (by as much as a factor of 4) than is predicted by basic magnetohydrodynamic shock theory. A correction is applied to basic theory for the loss of flux-bearing material to the boundary layer along the shock tube wall, resulting in rough agreement between observed and calculated field compression. The magnetic field decrease following behind the field compression is found to be a result of the appearance of diamagnetic discharge plasma directly behind the shock transition region. The presence of the discharge plasma in this region is attributed to a contact surface instability, which has been found to be often associated with electromagnetic shock tube flow. The diamagnetic currents within the discharge plasma are adequately described by a resistive electrical circuit model. (Diss. Abstr. Int., B)

52806 MEASUREMENT OF X RAYS FROM A PLASMA BY Si(Li) DETECTOR. **Matsukawa, Yoshinobu** (Osaka City Univ.). Jap. J. Appl. Phys.; 10: No. 8, 1295-6(Aug 1971).

X-rays from a beam–plasma discharge were measured through a Mylar foil window 40-μ thick at the end of a copper pipe protruding from the stainless steel part of the discharge chamber. The distributions of pulse height measured on the photographs of x-ray detection are shown in case (a) from the plasma volume, (b) from the stainless steel target inserted in the plasma volume and (c) from ^{55}Fe isotope. (M.O.W.)

52807 LACK OF PARTIAL THERMAL EQUILIBRIUM IN PINCH DISCHARGES. **Engelhardt, W.; Koeppendoerfer, W.; Sommer, J.** (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys.; 246: No. 1, 29-42(1971).

Measurements of the deuterium Balmer line intensities in the early phase of a theta-pinch discharge show strong deviations from steady-state population of levels considerably above the collision limit, even if criteria for the relaxation times of these levels are well satisfied. Solutions of time-dependent rate equations for a hydrogen plasma confirm these observations. In cases of rising electron temperatures and rising degree of ionization, the population of the ground level deviates by orders of magnitude from the steady-state population of the momentary electron temperature and density. The population rates from the highly overpopulated ground level into levels above the collision limit then successfully compete with population rates from other levels and the continuum. Under such circumstances the relaxation time of excited levels above the collision limit into thermal equilibrium is determined by the relaxation time of the ground level into its steady-state population. (auth)

52808 INVESTIGATION OF LUMINESCENCE OF HIGH-FREQUENCY PLASMA JET AT REDUCED PRESSURE IN RELATION TO GAS COMSUMPTION. **Bezukh, B. A.; Skutov, D. K.** Zh. Prikl. Spektrosk.; 11: No. 2, 227-9(Aug 1969). (In Russian).

Apparatus for obtaining plasma jets with high-frequency generators is described. Change of intensity of argon lines in relation to gas consumption at reduced pressure was studied. The luminescence characteristics in different regions of the discharge tube both for constant-cross-section and contoured nozzles is described. Also, the luminescence characteristics of the spectral lines of ions and neutral atoms of argon along the axis of the plasma jet were studied. (tr-auth)

52809 GAS DYNAMICS OF A LASER PLASMA DURING HEATING. **Basov, N. G.; Boiko, V. A.; Gribkov, V. A.; (and others) (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 1, 154-61(Jul 1971). (In Russian).**

The gas-dynamic properties of a laser plasma produced by focusing a powerful laser beam on the surface of a carbon target were investigated experimentally. The time variation of plasma pressure in the heating zone, of mass flow from the target surface, and of heated plasma mass are measured by the technique of slit scanning of the interferogram by an image converter. The gas-dynamic processes taking place in the heated plasma are discussed. It is found that, in the case of a multimode Q-switched laser, maximum pressure in the plasma is attained at the beginning of the pulse. The highest pressure attained in the plasma is 10^6 atm. (auth)

52810 ELECTRON BREMSSTRAHLUNG IN THE FIELD OF ARGON OR HELIUM ATOMS. **Batenin, V. M.; Chinnov, V. F. (Inst. of High Temperature, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 1, 56-63(Jul 1971). (In Russian).**

The spectral distribution of free–free radiation intensity in the field of argon or helium atoms is measured experimentally in the 10^4 to 35×10^3 cm^{-1} frequency range. The cross section for bremsstrahlung energy absorption is investigated at temperatures between 4×10^3 and 8×10^3 °K. The experimental results are compared with various approximate calculations of bremsstrahlung processes in Ar and He atomic fields. It is demonstrated that approximate methods of calculating the intensity of bremsstrahlung continuum can be employed for determining the main plasma parameters. (auth)

52811 FINE STRUCTURE OF THE DISTRIBUTION FUNCTION OF AN ELECTRON BEAM INTERACTING WITH A PLASMA. **Levitskii, S. M.; Nuriev, K. Z. (Kiev State Univ.). Zh. Eksp. Teor. Fiz.; 61: No. 1, 190-7(Jul 1971). (In Russian).**

Fine structure of the distribution function of an electron beam that had interacted with a plasma is observed by employing a high-resolution energy analyzer. The fine structure consists of a number of weak peaks appearing on the plateau background. The dependence of the fine structure on the regime and geometry of the plasma–beam system is investigated. The effect of modulation of the beam by a monochromatic signal is studied. Appearance of the fine structure is explained as being the result of beam electron capture in potential wells of a number of discrete intrinsic waves of the system. (auth)

52812 OSCILLATIONS IN ION BEAM–PLASMA SYSTEM. Ohnuma, T.; Fujita, T.; Hatta, Y. (Tohoku Univ., Sendai). Phys. Lett.; 36A: No. 4, 265-6(13 Sep 1971).

Low-frequency oscillations are observed when controlled ion beams are injected into controlled plasmas. (auth)

52813 EXPERIMENTAL STUDY OF SPECTRAL INDEX, MODE COUPLING, AND ENERGY CASCADING IN A TURBULENT, HOT-ION PLASMA. Roth, J. Reece (Lewis Research Center, Cleveland). Phys. Fluids; 14: No. 10, 2193-2202(Oct 1971).

The spectrum of electrostatic potential fluctuations was measured with a capacitive probe in a steady-state, turbulent plasma confined in a magnetic mirror geometry. The plasma conditions ranged over $5 \times 10^7 \leq n_e \leq 5 \times 10^8/\text{cm}^3$, $8 \leq T_e \leq 38$ eV, $350 \leq T_i \leq 930$ eV, and $B_{max} = 1.0$ T. When oscillation peaks were absent, the amplitude spectrum of electrostatic potential fluctuations had a power-law dependence on frequency of the form $\phi = \phi_0 \nu^{-n}$ over the range 0.2 to 1.0 MHz. The value of the spectral index n depended on the probe position in the magnetic field, and, at a given position, depended on the plasma characteristics. The spectral index was generally below the value $n = 2.5$ predicted by some turbulence theories formulated in k space. Enhancement of the turbulent spectrum on the high-frequency side of oscillation peaks suggests that the direction of net energy flow in the turbulent spectrum is from low frequencies to high frequencies in this plasma. The effects on the amplitude spectrum of a sinusoidal external modulation of the anode voltage were assessed over the range 0 to 100 kHz. The spectra exhibited several mode coupling phenomena, including enhanced harmonics of the externally imposed frequency, and sideband modulation of plasma-generated oscillation peaks. External excitation of the plasma at frequencies below 50 kHz resulted in only a small degree of ion heating. (auth)

Kinetics (Theoretical)

Refer also to abstracts 52498 and 52984.

52814 (AD–718436) QUANTUM-MECHANICAL STUDY OF PLASMAS. PART I. INTERACTION OF WAVES WITH PLASMA DENSITY GRADIENTS. **Final Report. Ashby, Neil; Boulanger, Philippe (P.E.C. Research Associates, Inc., Louisville, Colo.). Oct 1970. Contract F33615-69-C-1554. 107p. (ARL–70-245). NTIS.**

An improved statistical model for electrons in atoms is developed, based on an expansion of the one-electron Green's function in spherical harmonics. Improved results in the total energies and electron densities near the nucleus, as compared with the Thomas–Fermi model, are obtained. The model is generalized to include relativistic effects. An improved treatment including retardation effects of surface plasmon dispersion relations, and of the transmission and reflection coefficients for light incident on a semi-infinite plasma, is given. An exact method for solution of a system of coupled differential equations with periodic coefficients is discussed and applied to electromagnetic wave propagation through a gas of spins, and to the Bloch equations for a magnetic moment in an oscillating magnetic field. (auth) (USGRDR)

52815 (IPPJ-DT–23) RADIAL MOTION OF PLASMA IN THETA PINCH. Kawakami, Ichiro (Nagoya Univ. (Japan). Inst. of Plasma Physics). Dec 1970. 70p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Simulation of plasma pinch phenomena has been successful by the use of equations of electromagnetic hydrodynamics. This report is a manual to use a program for the computer simulation of plasma moving in a radial direction that can be observed in theta or z pinches. It is assumed that the plasma is cylindrically symmetric, and has no dependence in z (axial) and Θ (azimuthal) directions. The plasma is compressed by magnetic fields produced by current flowing through an outer coil and, if necessary, by current flowing in a hard core. The program is constructed so that only the magnetic field by the outer coil acts when radius r_c of the hard core is zero, and both fields by the currents in the hard core and the outer coil act when $r_c \neq 0$. The plasma is composed of ion and electron fluids. Difference between densities of two fluids is disregarded. Equations to express the plasma and a method of numerical analysis are explained. Notes to use the program are described. Flow charts and the program itself written in FORTRAN IV are shown. (Japan)

52816 (UUIP–724) SHELL STRUCTURE IN A PLASMA. **Kjellmert, Bo (Uppsala Univ. (Sweden). Inst. of Physics). Nov 1970. 78p. Dep. NTIS (U. S. Sales Only).**

Axially and azimuthally symmetric systems of charged particles in an external axial, homogeneous, magnetic field are studied. Stationary, self-consistent systems are constructed, in which the Lorentz force balances the centrifugal force. A comparison system is introduced in order to normalize expressions of angular momentum and energy. For simplicity, a thin layer of particles at rest is chosen as comparison system. This system is looked upon as an initial system from which the stationary system has developed. Especially, systems for which minimum energy is associated with the motion of the charged particles are considered. The number of particles and the angular momentum are assumed to be known constants. The plasma is supposed to be cold. This investigation consists of two parts. In Part I, electrons and ions are supposed to rotate around a common axis. Minimum energy is proved to occur when the particles are concentrated in thin layers or shells. If there is only one shell and the number of electrons is almost equal to the number of ions, the corresponding azimuthal velocity for the stationary state is very small compared with the velocity of light. In the (almost) force-free state, the radius of this shell with minimum energy is determined approximately by a variational method. In Part II, electrons are supposed to form the system. The minimum of the energy associated with the motion of the electrons is shown to occur for the electrons concentrated in a thin layer, if they rotate at ultrarelativistic velocities. Two special cases are considered in which the assumption of ultrarelativistic velocities is confirmed. The velocity of the electrons and the radius of the shell are related to the total number of electrons, to the external magnetic field, and to the total angular momentum of the shell. It remains to be proved whether or not a shell is the minimum energy configuration also for lower velocities. (auth) (Sweden)

52817 FORMATION OF A PLASMA SHEATH. **Anderson, N.; Walsh, G. R. (Univ. of York, Eng.). Int. J. Electron.; 31: No. 3, 217-22(Sep 1971).**

XUM

The electric potential variations in space and time during the formation of a plasma sheath are considered. The variation of the wall potential in time, the potential profile at various stages of the sheath formation, and the variation of the total current at the wall are given. (auth)

52818 THEORY OF CRITICAL SCREENING RADIUS OF ENERGY LEVELS OF HYDROGEN-LIKE ATOMS IN PLASMAS. **Totsuji, Hiroo (Tokyo Univ.). J. Phys. Soc. Jap.; 31: No. 2, 584-90(Aug 1971).**

The electric states in the Debye–Hueckel potential, $-(Ze^2/r)\exp(-r/D)$, are investigated and the critical screening radius $D = D_c(n,l)$ is given by the simple formulas $[ZD(n,0)/a] = \pi/4\, n^2$ (for $l = 0$) and

$$\frac{n-l-\frac{1}{2}}{l+\frac{1}{2}} = \frac{1}{\pi}\left(\frac{2ZD_c(n,l)}{a(l+\frac{1}{2})^2}\right)^{\frac{1}{2}} \int dt \left(\frac{\exp(-t)}{t} - \frac{a(l+\frac{1}{2})^2}{2ZD_c(n,l)} \cdot \frac{1}{t^2}\right)^{\frac{1}{2}}.$$

(for $l \neq 0$), where n and l denote the principal and azimuthal quantum numbers, respectively, and $a = \hbar^2/me^2$. By a comparison with the results of numerical calculations, it is ascertained that these formulas hold with sufficient accuracy. The method is to connect the quasi-classical solution of the Schroedinger equation with the solution for the pure Coulomb potential in the region where both approximations are valid. (auth)

52819 QUASI-NEUTRAL INHOMOGENEITY IN COLLISIONLESS PLASMA. **Suchkov, A. A. (Inst. of Astrophysics, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 14: No. 2, 18-20 (1971). (In Russian).**

The process of dispersion of a cloud of high-temperature electrons in cold plasma was examined for the case in which the initial electron concentration was much less than the concentration of the plasma. It is proposed that during dispersion the cloud will remain quasi-neutral. By defining the pertinent quantities and employing the Laplace transform, it is demonstrated that, within a hot plasma, inhomogeneity practically has no tendency to spread; under these conditions a stationary density distribution is asymptotically established. (K.S.W.)

52820 ASYMPTOTIC SOLUTION OF THE PROBLEM OF ANOMALOUS RESISTANCE OF A COLLISIONLESS PLASMA. **Vekshtein, G. E.; Ryutov, D. D.; Sagdeev, R. Z. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 60: No. 6, 2142-54(Jun 1971). (In Russian).**

The temporal evolution of the charged-particle distribution function in a homogeneous plasma in an external electric field E is considered. It is shown that, in the limit $t \rightarrow \infty$, the distribution functions vary in a self-similar fashion, all velocities linearly increasing in time. It is found that when the current is parallel to the external magnetic field, the directed electron velocity v_e varies essentially in the same way as during free acceleration: $v_e = \alpha eEt/m$, where α is a numerical coefficient which is smaller but of the order of unity. If the current is perpendicular to the external magnetic field no runaway occurs, and the ratio of the directed electron velocity to thermal velocity becomes much smaller than unity. (auth)

52821 EFFECT OF INITIAL CONDITIONS ON THE BEHAVIOR OF ELECTRON DENSITY INHOMOGENEITY IN A PLASMA. **Suchkov, A. A. (Inst. of Astrophysics, Dushanbe, USSR). Zh. Eksp. Teor. Fiz.; 60: No. 6, 2128-33(Jun 1971). (In Russian).**

The effects of thermal motion of inhomogeneity electrons and the motion of the inhomogeneity as a whole on behavior of the latter in a collisionless plasma are considered. It is shown that, in a cold plasma, thermal motion of inhomogeneity electrons results in pulsations that are imposed on the ordinary plasma oscillations. In a hot plasma the inhomogeneity is partially smeared out, and a stationary distribution of its density is asymptotically established. Correspondingly, a stationary macroscopic electric field arises, the strength of the field being proportional to the initial inhomogeneity of the electron temperature. It is found that the inhomogeneity can move in the plasma as a whole only if a certain relation exists between its dimensions and plasma parameters. At a sufficiently high initial velocity the inhomogeneity moves as a whole without exciting, in a first approximation, plasma oscillations and without smearing out. The low initial velocity only leads to oscillatory shifting of the density along the initial velocity direction. It is demonstrated that an uncompensated low-density electron (or ion) beam cannot excite beam instability. (auth)

52822 STRUCTURE OF THE TRANSITION LAYER IN A HIGH-FREQUENCY GAS DISCHARGE. **Meierovich, B. E.; Pitaevskii, L. P. (Physical Lab., Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 1, 235-42(Jul 1971). (In Russian).**

The structure of an equilibrium high-frequency gas discharge under strong skin-effect conditions is investigated. An analytic dependence of the plasma temperature on input power is derived. It is shown that the power required for heating the plasma to a certain temperature depends on the thermal conductivity and electric conductivity of the gas at a certain temperature and is independent of the discharge dimensions and geometry under strong skin-effect conditions. In the transition region at the discharge boundary the temperature, high-frequency energy flux, and power absorbed in the discharge can be expressed in terms of a universal function of the coordinates. The results are applicable to induction discharges as well as to discharges in volume resonators. (auth)

52823 INJECTION OF A RELATIVISTIC ELECTRON BEAM INTO A PLASMA. **Rukhadze, A. A.; Rukhlin, V. G. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 1, 177-89(Jul 1971). (In Russian).**

The response of a plasma to injection of a low-density relativistic electron beam is investigated. It is shown that if $r_0 > c/\omega_p$, where r_0 is the beam radius and ω_p the plasma frequency, all plasma perturbations are localized in the region of the electron beam itself; all currents induced in the plasma tend to compensate the magnetic field of the beam, facilitating in this way its injection into the plasma. If the beam injection time $\tau > \tau_0 = \nu^{-1}(r_0\omega_p/c)^2$, where ν is the plasma electron collision frequency, then magnetic field compensation occurs at distances $z < z_0 = u\tau_0$ from the front of the beam, u being the directed electron velocity. Hence, in the case of a high-current electron beam, when the magnetic energy of the beam current exceeds the electron kinetic energy, easy injection is possible only in a dense plasma, providing $\omega_p > c/r_0$ and $\tau < \tau_0$. (auth)

52824 DIFFUSION IN A HIGHLY IONIZED THERMAL PLASMA IN A MAGNETIC FIELD. I. CALCULATION OF DENSITY PROFILES. **Fuchs, G. (Univ., Marburg, Ger.). Ann. Phys. (Leipzig); 26: No. 1, 49-58(1971). (In German).**

A thermal cs plasma was produced by contact ionization at the surface of a hot tungsten helix spanned in the axis of a cylindrical glass vessel. The plasma density profile n(r,z) as a function of a magnetic field in the direction was measured with a movable Langmuir probe and compared with the calculated profiles. The cross section for collisions of the ions and electrons with the neutrals can be calculated. The density n(r,z) is calculated from the diffusion equation. In the calculations, collisions of the carriers with the neutrals as well as Coulomb collisions are taken into account. This leads to a nonlinear partial boundary-value problem. Methods for numerical solution and numerical solutions are given. (auth)

52825 THEORY AND EXPERIMENTS FOR A PLASMA MODEL USING FINITE-SIZE PARTICLES. **Okuda, Hideo. Berkeley, Calif.; Univ. of California (1970). 119p. University Microfilms Order No. 71-20,876.**

Thesis.

Both theoretical and experimental studies of a computer plasma model that uses finite-size charged particles, called clouds, were performed. Theoretical investigations were made of collisions in a plasma of clouds. The potentials and forces between clouds including the effect of shielding, scattering cross section, and the kinetic equations of Balescu–Lenard and Landau are studied. It is shown that the collisions in a plasma of clouds are greatly reduced compared with those in a plasma of zero-size particles. Computer experiments are described that check the theoretical predictions, using large clouds with negligible grid effects. Fluctuation spectrum of the electric field in k-space, dispersion, correlation function and Landau damping of the Fourier modes of the electric field, drag on a particle, particle diffusion in velocity space, Debye shielding, wakes excited by fast particles and the frequency spectrum of the Fourier modes were measured. The experimental results are in good agreement with the theoretical predictions. Nonphysical instabilities in a simulation plasma arising from the use of a spatial grid for charge and force sharing are treated experimentally, showing that nonphysical instabilities can develop even in a thermal plasma when the Debye length is small compared with the grid size. (Diss. Abstr. Int., B)

52826 NUMERICAL SIMULATION OF SPARK DISCHARGES IN AIR. **Plooster, Myron N. (National Center for Atmospheric Research, Boulder, Colo.). Phys. Fluids; 14: No. 10, 2111-23 (Oct 1971).**

A numerical model is presented that describes the evolution with time of a short segment of a spark channel in air and its associated acoustic wave. The model assumes a straight, cylindrical conducting column in which local thermodynamic equilibrium exists at every point. The electrical energy input to the column is determined by a prescribed electrical current waveform, coupled with a computation of the plasma conductivity. The evolution with time of the conducting column and its surrounding flow field is then found by numerical integration of the equations of gas dynamics. The model employs a realistic equation of state for air at high temperatures, and incorporates kinetic and radiative energy transport processes. It is shown that a satisfactory description of the properties of a spark channel cannot be achieved when radiative transport processes are neglected. The model agrees well with experimental measurements of spark channel radii, temperatures, pressures, and electron densities, and predicts the resultant shock wave strengths closely. The voltage gradients along the spark channel predicted by the model, and the total energy input to the channel, are not as uniformly in agreement with experiment. Possible reasons for these discrepancies are discussed. (auth)

52827 INTERACTION BETWEEN AN ELECTRON BEAM AND INTRINSIC OSCILLATIONS IN A RESTRICTED PLASMA. **Veselovskii, I. S. (Inst. of Nuclear Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 1, 174-6(Jul 1971). (In Russian).**

Interaction between an electron beam and intrinsic oscillations in a homogeneous plasma layer is analyzed by using the collisionless kinetic equation. A correction to the distribution function is determined in the second order of perturbation theory with respect to magnitude of the plasma-oscillation electric field strength. After averaging over time, the correction is found to oscillate with respect to velocity and coordinate. This phenomenon has apparently been observed recently. (auth)

52828 PROPAGATORS IN STRONG PLASMA TURBULENCE. Birmingham, T. J. (Goddard Space Flight Center, Greenbelt, Md.); Bornatici, M. Phys. Fluids; 14: No. 10, 2239-41(Oct 1971).

Straightforward relationships among Weinstock's propagator, U_A, the Vlasov propagator, U, and the ensemble average Vlasov propagator, ⟨U⟩, are derived. U and ⟨U⟩ are related to the characteristic trajectories of the Vlasov equation. (auth)

52829 SELF-CONSISTENT RELATIVISTIC BEAM EQUILIBRIA. Rensink, Marvin E. (Univ. of California, Livermore). Phys. Fluids; 14: No. 10, 2241-2(Oct 1971).

Self-consistent solutions to the Vlasov–Maxwell equations are given for three types of relativistic beams: (a) the current density is hollowed out on axis; (b) the current density is peaked on axis; and (c) the current density is uniform. The models used here give beams with sharp radial boundaries. (auth)

52830 GENERALIZED EQUATIONS FOR PLASMA OF ARBITRARY COLLISION FREQUENCY IN WEAKLY INHOMOGENEOUS MAGNETIC FIELD. Stringer, T. E.; Connor, J. W. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids; 14: No. 10, 2177-83(Oct 1971).

A closed set of equations relating the macroscopic variables are derived from the linearized kinetic equations with a Bhatnagar–Gross–Krook collision term. The collisional fluid limit of these expressions is in complete agreement with the most exact magnetohydromagnetic equations, including viscosity. The collisionless fluid limit provides an extension of the Chew–Goldberger–Low equations, now valid when the diamagnetic velocity is comparable to the electric drift. The generalized equations may be used to investigate the transition between the weakly collisional condition, where resonant-particle effects are important, and the strongly collisional condition where viscosity becomes dominant. (auth)

Production

52831 (AD–720847) ROTATING R-FIELD PLASMA FOR THERMONUCLEAR POWER REACTORS. **Final Report, March 1, 1969–October 31, 1970. Pool, Marion L. (Ohio State Univ., Columbus. Dept. of Physics). Feb 1971. 10p. (AFOSR-TR-71-730). NTIS.**

A hydrogen plasma was created in a magnetic bottle by the use of a two-phase oscillator operated at a cyclotron frequency of 4.225 MHz. Ion densities and energies in the neighborhood of 5 × 10^{12}/cm^3 and 400 eV were achieved. A disc-type dense plasma focus device of 8$\frac{3}{4}$-inch diameter operated best at a deuterium pressure of 0.7 torr. Ion densities and energies in the neighborhood of 10^{19}/cm^3 and 100 eV were achieved. (auth) (USGRDR)

52832 (AD–721214) MAGNETIC-FIELD ANNIHILATION OF PLASMAS FOR ADVANCED PLASMA ENGINE DESIGN. **Final Report. Dailey, C. L. (TRW Systems Group, Redondo Beach, Calif.). 31 Mar 1971. Contract F44620-70-C-0035. 39p. (TRW–14649-6001-RO; AFOSR-TR-71-328). NTIS.**

The ejection of energetic streams of plasma from the Sun during solar flares indicates the action of a powerful acceleration process. This mechanism has been explained in terms of the rapid release of magnetic field energy resulting from the collision of streams of plasma carrying oppositely directed magnetic fields. In such a collision the field is annihilated and the corresponding energy is converted to kinetic energy of the ejected plasma. A two-coil pulsed inductive machine has been built at TWR Systems that makes use of this process to accelerate and heat a plasma. In one region of the machine the solar flare process is produced and the energy released by magnetic field annihilation is converted to kinetic energy. The information obtained from experiments in this region of the machine can be applied to the design of a high-performance pulsed plasma thruster. In a different region of the device the magnetic field energy is converted to ion heating and compression. The application of the field annihilation mechanism may be useful for controlled thermonuclear fusion. This report describes the two-coil accelerator and reviews the background upon which the experimental investigation is based. Construction of the machine is finished and testing of the control circuitry is proceeding. (auth) (USGRDR)

52833 (IPP-IV–16) PRODUCTION OF PLASMA WITH A CO_2-TEA-LASER FROM SOLID HYDROGEN TARGETS. **Buechl, Klaus (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar 1971. 27p. Dep. NTIS (U. S. Sales Only).**

A hydrogen plasma is produced with a CO_2–TEA laser of about 1-MW power. The plasma is investigated with probes, streak and short-time photography, transmission measurements, holographic interferometry, and shadowgrams with a ruby laser. The measurements are compared with a theory of plasma production by laser from solid targets and good agreement was found also for 10.6-μ laser radiation. Recombination is found to be important in this experiment. (auth)

52834 (N–71–22676) EVALUATION OF AN ABNORMAL-GLOW DISCHARGE FOR USE AS A LABORATORY PLASMA SOURCE. **Roberts, Albert S. Jr.; Grantham, William L. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Apr 1971. 30p. (NASA-TN-D–6136). NTIS.**

Abnormal glow-discharge plasmas from both needle- and inverted-brush cathode configurations were studied for potential use as laboratory test beds to develop and calibrate plasma diagnostic sensors. Electron densities of 10^{12} electrons/cm^3 were produced with short-term variations <±6% and long-term (several months) repeatability >±15%. Measured plasma profiles were in good agreement with linear diffusion theory for uniformly spaced brush elements; however, an attempt to shape the steady-state profile by tailoring the cathode distribution did not produce the theoretically predicted result. During tube warmup, some profile shaping was observed. (auth) (STAR)

52835 INDUCTION PLASMAS AT LOW FREQUENCIES. **Eckert, Hans U. (Aerospace Corp., El Segundo, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 8, 1452-6(Aug 1971).**

The possibility of generating thermal electrodeless plasmas at frequencies below the rf range through the use of magnetic materials was investigated, both analytically and experimentally. Existing minimum frequency and voltage criteria for the maintenance of quasi-steady, tube filling ac arcs were combined with the induction law to yield design criteria for a "plasma transformer," which consists of a conventional iron core and primary but has the secondary replaced by a torus-shaped vessel containing a single plasma turn. The idea was tested, at a frequency of 9600 Hz, on a small model with an iron core of 100 cm^2 cross section. Glow and arc discharges at pressures up to 600 torr were generated in argon. Applicability to operation at 60 Hz is discussed. (auth)

52836 PALLADIUM PLASMA SOURCE. **Nakagawa, Yoshiro; Watanabe, Kenji (Osaka City Univ.). Jap. J. Appl. Phys.; 10: No. 8, 1280-81(Aug 1971).**

Results are reported of the mass analysis of plasma ions from a titanium plasma source and that from a new plasma source with palladium electrodes which were operated in the vacuum chamber in which the oil-less high vacuum (P = 8 × 10^{-9} torr) can be achieved. (M.O.W.)

52837 EXPERIMENTAL STUDY OF EFFECTS OF LOCAL FLUID CONSTRICTION ON THE CONFINED-DISCHARGE PLASMA GENERATOR. **Mahan, James Robert. Lexington, Ky.; Univ. of**

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Kentucky (1970). 232p. University Microfilms Order No. 71-19,380.

Thesis.

A method for improving the performance of confined discharge plasma generators was investigated experimentally. Normally, the energy conversion efficiency of a confined discharge plasma generator is inversely related to the mean enthalpy of the effluent plasma jet. However, both the energy conversion efficiency and the mean plasma enthalpy can be increased if a portion of the working fluid is injected into the fully developed discharge column with a high radial velocity. The fluid is introduced through a narrow circumferential slit in the confining duct wall located in the asymptotic region. Cooling and fluid-dynamic effects associated with this inflow of cold gas cause the local discharge column to become highly constricted. Commensurate with this local fluid constriction (LFC) is a sharp increase in the local power density, resulting in enhanced energy transfer to the cold gas. The relative performances of confined discharge plasma generators with and without LFC are compared experimentally, and the LFC mechanism is explained in terms of experimental results. Calorimetric energy-balance techniques are employed to verify that LFC leads to higher energy conversion efficiencies and higher mean plasma enthalpies. Also, plasma spectroscopy reveals that higher temperatures are obtained in both the discharge column and the plasma jet when LFC is employed. Potential and pressure distributions within the confining duct provide valuable information about the development of the discharge within the duct while lending much insight into the mechanisms that govern the observed improvement in performance. It is determined that optimum performance is obtained when the injection slit is located at the axial position where the discharge just becomes fully developed. (Diss. Abstr. Int., B)

52838 PLASMA PRODUCTION BY MOLECULAR ION INJECTION INTO A MAGNETIC MIRROR SUPPLEMENTED WITH A RADIO FREQUENCY ELECTRIC FIELD. Akimune, H.; Kishimoto, S.; Narikawa, T.; Suita, T. (Osaka Univ.). Phys. Fluids; 14: No. 10, 2223-31(Oct 1971).

Observations with a 27-keV molecular ion injection experiment are described. In an experiment, an rf electric field is applied transversely to a containing magnetic mirror field in the mid-region. The rf-field intensity is proportional to r^4, and the frequency relation is $\omega = 2.5\ \omega_{ci} = 5\ \omega_{cm}$, where r is the radius, and ω_{ci} and ω_{cm} are the cyclotron frequencies of protons and hydrogen molecular ions, respectively. Accumulation of plasma greatly increases with an rf potential of about 1.4 kV, and a density of 7×10^7 particles/cm^3 is obtained with an injection current of 2 mA. Perpendicular proton velocity distribution is well spread with an rf potential of about 1.4 kV. The spreading is caused during the process of deceleration of the injected molecular ions. Emissions at the second harmonic and the fourth harmonic of the proton cyclotron frequency are observed. Intensity of the fourth harmonic is reduced with a rise in strength of the rf field. As the rf field is switched off, there are plasma loss processes other than charge exchange. The loss may be due to a low-frequency drift instability. In the presence of the rf field, however, there is no evidence of plasma loss by processes other than charge exchange. The rf field may set up a sufficiently deep well of equivalent quasipotential for ions of the present low-density plasma. (auth)

52839 PRODUCTION AND INVESTIGATION OF VERY STRONG IONIZING SHOCK WAVES. Halmoy, Einar (Columbia Univ., New York). Phys. Fluids; 14: No. 10, 2134-43(Oct 1971).

Experiments are described in which shock speeds up to 1% of the speed of light were achieved in gaseous hydrogen or deuterium Separation between the transverse shock wave and the drive current are clearly observed. The density and magnetic field shock compressions are measured and the post-shock electron temperature, determined from plasma x-ray bremsstrahlung spectra, is found to be about 10^7 °K. Neutron emission was detected from shocks in deuterium. The axial electric field in the shock structure is measured and interpreted as resulting from a combination of Hall effect and ion displacement current. (auth)

Stability

Refer also to abstract 52869.

52840 (IAE-2044) EXPERIMENTAL STUDY OF ION-CYCLOTRON INSTABILITIES OF A PLASMA PRODUCED BY A FAST ION BEAM. Bortnikov, A. V.; Brevnov, N. N.; Zhukovskii, V. G.; Romanovskii, M. K. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 50p. (In Russian). Dep. NTIS (U. S. Sales Only).

Ion-cyclotron oscillations occurring in a low-density plasma ($\omega_{\rho i}^2 \ll \omega_{Bi}^2$) after its capture in a trap with magnetic mirrors are investigated. It was established that the oscillations are caused by two different types of ion-cyclotron instabilities. The time and spectral characteristics of the instabilities are measured. The thresholds for the development, the wavelengths and increments of the developing oscillations were determined. It was found that the form of the velocity distribution function of the ions affects the development of the oscillations in a considerable way. The effect of a decrease in the longitudinal dimension of the plasma, certain nonlinear characteristics of the oscillations, and consequences to which the development of both instabilities lead are discussed. It is observed that the first instability leads to heating and the expulsion of electrons along the magnetic field and the expulsions of ions across the field. The second instability did not cause additional particle losses from the trap. A preliminary comparison of experimental data with the linear theory of ion-cyclotron instabilities of a homogeneous plasma is given. It is shown that the experimental results on the second instability agree best with the conclusions of the theory of anisotropic nonresonance instability. The first instability could not be identified due to the difficulty of measuring the wavelengths of the oscillations. (JPRS)

52841 NATURE OF THE LARGE-SCALE INSTABILITIES IN TOKAMAK. Mirnov, S. V.; Semenov, I. B. Zh. Eksp. Teor. Fiz.; 60: No. 6, 2105-12(Jun 1971). (In Russian).

Experiments on excitation and investigation of macroscopic instabilities of plasma filaments in Tokamaks are described. Instabilities arising on reduction of $q(a) = H_z\alpha/H_\varphi R$ down to a value of unity, and also instabilities arising when the critical concentration is exceeded and equilibrium of plasma loop is violated, are investigated by the correlation technique. The possibility of reducing all these instabilities to a single type, viz., to instability of resonance perturbations either at the boundary or near the boundary or the plasma filament are considered. (auth)

52842 NONLOCAL THEORY OF TRAPPED PARTICLE INSTABILITY. Bhadra, Dilip K.; Liu, Chuan Sheng (Gulf General Atomic Co., San Diego, Calif.). Phys. Fluids; 14: No. 10, 2152-7(Oct 1971).

A nonlocal theory for the low-frequency trapped particle instability in toroidal systems is developed in a model field. The stability of the trapped particle mode is studied by using normal-mode analyses with radial boundary conditions. In the absence of magnetic shear, the finite-orbit effect is shown to be incapable of stabilizing the mode; large magnetic shear is needed for stabilization. The ratio of the localization width of the mode to the characteristic density length is of the order of $(\Lambda/r)^{1/2}\epsilon^{1/2}$ (Λ is the characteristic "banana" size, r is the characteristic density length, and ϵ is the aspect ratio). An estimate of the nonlinear diffusion coefficient for the mode is given. (auth)

52843 NONLOCAL BEHAVIOR OF ION SOUND INSTABILITY IN COLLISIONLESS SHOCK WAVE. Bajaj, N. K.; Krall, N. A. (Univ. of Maryland, College Park). Phys. Fluids; 14: No. 10, 2158-63(Oct 1971).

The stability of a magnetic pulse with respect to ion acoustic–electron drift waves is studied, using a realistic magnetic profile instead of the local approximation customarily analyzed. The stabilizing effect of nonlocal corrections is noted, and the condition for validity of local approximation in this case is obtained. (auth)

52844 ONE-DIMENSIONAL SIMULATION OF RELATIVISTIC STREAMING INSTABILITIES. McKee, Christopher F. (Univ. of California, Livermore). Phys. Fluids; 14: No. 10, 2164-76(Oct 1971).

A relativistic version of the one-dimensional cloud-in-cell model for plasma simulation is developed. The model is physically self-consistent despite the omission of transverse, electromagnetic waves. The conditions for the onset of relativistic electrostatic instabilities between two electron beams and between two identical counterstreaming plasmas are derived for the case in which the one-dimensional and three-dimensional results are identical. In particular, the ion–ion instability can occur only for extremely high electron temperatures. Collisional effects in the model are discussed. Supraluminous waves are shown to be generated both by collisional effects and by nonlinear interactions in unstable plasmas. The results of the simulation of the instabilities are consistent with the theory. With the exception of the behavior of vortexes in position-momentum phase space, the relativistic results correspond reasonably well to the nonrelativistic ones. (auth)

Thermonuclear Processes

52845 (A/CONF.49/P–488) PROGRESS ON RESEARCH TOWARDS A CONTROLLED THERMONUCLEAR REACTOR. Pease, R. S. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). May 1971. 15p. (CONF-710901-216). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

U.K. Atomic Energy Authority research on the problem of confining high-temperature plasma by magnetic fields is reviewed. Experimental and theoretical studies of confinement systems that might form the basis of future reactors — Toroidal Pinches, Stellarators, and Mirror Machines — have been made, together with experiments in simpler geometries to elucidate the principles of magnetic confinement. Plasmas with a wide range of density and temperature have been confined for times ranging up to about 0.1 sec. The conditions required for gross stability are found to be in good agreement with theory. In addition, significant suppression of Bohm diffusion has been observed. Confinement times (or cross-field diffusion coefficients) observed in a number of experiments, including those in stellarators, are encouragingly close to those calculated for collisional diffusion alone which is sufficiently slow in reactor conditions to allow power production from the $D(T,n)^4He$ fusion reactions. The ratio of plasma pressure to magnetic pressure has reached 10% in a number of experiments, indicating that the efficient use of magnetic pressure necessary for a reactor can be achieved in experimental conditions. Design studies incorporating progress in plasma confinement understanding with engineering and technological possibilities have lead to a reference design for a 5-GW(Th) toroidal reactor. Neutron spectra and fluxes (3×10^{15} cm^{-2} sec^{-1}) and the consequent transmutation and radiation damage rates have been estimated. The magnetic field generating system is likely to provide a significant part of the capital costs of the reactor. Recent theoretical studies indicate that the current generated by outward diffusion of reacting plasma can be used to amplify and sustain magnetic fields; if so, toroidal pinches of the Tokamak type might be operated as steady-state systems. (auth)

52846 (A/CONF.49/P–763) FINAL REPORT ON CONTROLLED NUCLEAR FUSION. Artsimovich, L. A. (State Atomic Energy Committee, USSR). Aug 1971. 9p. (CONF-710901-510). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A brief review of controlled thermonuclear research progress is given. Tokamak devices, magnetic mirrors, laser heating, and stellarators are discussed. (M.O.W.)

52847 (AD–720839) THERMONUCLEAR REACTION WAVES AT HIGH DENSITIES. Chu, Ming-Sheng (Columbia Univ., New York. Plasma Lab.). Mar 1971. Contract F44620-71-C-0010. 148p. (AFOSR-TR-71-729). NTIS.

Phenomena are studied of the ignition and the development of plane thermonuclear reaction waves propagating through solid-density deuterium–tritium plasmas. The motivation of this study is to explore and understand laser heating of solid D–T targets for possible controlled thermonuclear fusion applications. The state of the plasma can be described by a two-temperature gas and, in general, it is optically thin to its own radiation. The equations governing the change of density, velocity, electron temperature, ion temperature, and degree of reaction are derived from the conservation laws and the laws of reaction kinetics. The physics is contained within a set of five coupled nonlinear partial differential equations. Terms in the equations take explicit account of thermonuclear reactions and heating, conduction, electron-ion equilibration, bremsstrahlung cooling and other fluid dynamic effects. Qualitative behavior of the physical variables is discussed. Solutions of the equations are obtained by employing finite difference techniques. (auth) (USGRDR)

52848 (CLM-P–275) REPORT ON THE CULHAM SUPERCONDUCTING LEVITRON. Cornish, D. N. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Jun 1971. 11p. (CONF-710715-1). Dep. NTIS (U. S. Sales Only).

From Symposium on electromagnetic suspension; Southampton, England (12 Jul 1971).

This machine is being built to study the stability and confinement of hot plasma trapped in the magnetic field around a levitated superconducting ring carrying half a million ampere turns. Superconducting coils up to 1.2 meters mean diameter, and built by the latest techniques, are incorporated in the vacuum system to provide the vertical field. A brief description of this equipment, concentrating on the superconducting aspects, is presented together with performance data for the coils. (auth) (UK)

52849 (IPP-IV–18) SINGLE-EXPOSURE IMAGING DEVICE FOR INFRARED AND SUBMILLIMETER WAVELENGTH LASER RADIATION. Keilmann, F. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). May 1971. 32p. Dep. NTIS (U. S. Sales Only).

A detector for two-dimensional observations of infrared and submillimeter-wavelength radiation is described. It allowed mode structures and interference patterns to be imaged for the first time with the 337-μ radiation of an HCN laser. The image-conversion effect is based firstly on radiation absorption by a metal film and secondly on temperature display presented by the color shift in a liquid crystal layer. Irrespective of the wavelength of the infrared radiation, full contrast is achieved at the input energy density of 0.004 J/cm^2. Single pictures can therefore be taken in short exposure times, viz., 10^{-8} sec at a wavelength of 10.6 μ (CO_2-laser) or 10^{-6} sec at 337 μ (HCN laser). A spatial resolution of 100 line pairs per mm can be achieved if the exposure time is below 10^{-4} sec, which calls for a power density of at least 40 W/cm^2. (auth)

52850 (IPP–4/83) POSSIBLE TYPES OF FUSION REACTORS: REACTOR PHYSICS AND TECHNICAL PROBLEMS IN THEIR DEVELOPMENT. Daenner, W. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar 1971. 14p. (In German). Dep. NTIS (U. S. Sales Only).

The gradual approach to the Lawson criterion calls for fusion machines which, because of their increasing size, may become precursors of a fusion reactor. Three configurations of toroidal magnetic confinement investigated by the Max-Planck-Institut für Plasmaphysik at Garching and the specific problems of their development are explained. Their integration in a complete fusion reactor power plant is shown by means of a scheme which, moreover, shall demonstrate the various technologies necessary to be treated with particular engagement. Some problems are obviously related to the technology of today's nuclear reactors: neutron physics, radiation damage, and liquid-metal technology. The characteristic questions in fusion-reactor technology are presented for each of these topics. The different details and the common ones are pointed out. Finally, some hints are given where known methods of nuclear physics and technology are applicable to fusion-reactor research and where a parallel development is necessary, utilizing as much experience as possible. (auth)

52851 (KHFTI–70/49) EXPERIMENTAL DETERMINATION OF THE BASIC CHARACTERISTICS OF SPATIALLY PERIODIC MAGNETIC CONFIGURATIONS. Loktionov, Yu. M.; Sebko, V. P.; Tyupa, V. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

Specific features of magnetic configurations with a spatial magnetic axis of the "heliotron", "heliotorse," and "axisymmetric stellarator" type frequently make it impossible, in investigating magnetic fields with the aid of electron beams, to use mechanically a method applied for systems with a plane magnetic axis ("stellarator," "Torsatron"). A modification of this method is given here that makes it possible to investigate experimentally a number of important characteristics of configurations having a helical magnetic axis. The structures of magnetic surfaces, the position of spatial magnetic axes, the angles of rotational transformation, and the widths in a single-setting "heliotron" and a two-setting "heliotorse", used here as examples, were studied experimentally. (JPRS)

52852 (NP–18988) FUTURE OF WORLD ENERGY. Lehnert, Bo (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Dec 1970. 45p. (In Swedish). Dep. NTIS (U. S. Sales Only).

Future demands for the energy production are estimated and a survey of the energy reserves of the world is given. The development of the nuclear energy as the major future energy resource and its consequences are discussed. Both fission and fusion processes are considered and the problems and possibilities of the fusion reactor are examined in detail. (K.K.) (Sweden)

52853 Q-MACHINE CATHODE PRODUCING LARGE RADIAL ELECTRIC FIELDS. Jassby, D. L. (Princeton Univ., N. J.). Contract AT(30-1)-1238. Rev. Sci. Instrum.; 42: No. 9, 1355-9(Sep 1971).

A segmented cathode, consisting of two insulated concentric tantalum plates, is described. The tantalum sections are heated

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by radiation from a tungsten back plate, which in turn is heated by electron bombardment. The insulating material is alumina (Al_2O_3), which is effective up to 2100°K. Arbitrary voltage may be applied across the gap between the concentric front sections. When used as the hot end plate in a Q machine, this cathode maintains large radial electric fields in the plasma interior. (auth)

52854 ELECTROMAGNETIC APPARATUS FOR PRODUCING AND CONTAINING HIGH TEMPERATURE PLASMAS. Post, Richard F.; Moir, Ralph W. (to United States Atomic Energy Commission). U. S. Patent 3,582,849. 1 Jun 1971. Filed 3 Dec 1969.

Electromagnetic apparatus is described that includes a pair of C-shaped field coil segments for producing a magnetic field defining a quadrupole-type magnetic potential well that is suitable for containing a high-temperature plasma. The segments are adapted to be separately or concurrently energized with equivalent or relatively variable electrical currents so as to produce deeper potential wells for more effective containment and to permit a wide variety of manipulations, not possible with previous designs, to facilitate trapping and heating of the plasma. Other operations involved in the production and utilization of high-temperature plasmas may also be effected. (auth)

52855 TIME CORRELATIONS OF X-RAY SPECTRA WITH NEUTRON EMISSION FROM A PLASMA-FOCUS DISCHARGE. Bernstein, M. J.; Lee, C. M.; Hai, F. (Aerospace Corp., El Segundo, Calif.). Phys. Rev. Lett.; 27: No. 13, 844-7(27 Sep 1971).

Time correlations between neutron and x-ray emissions from a plasma-focus discharge are strongly dependent on photon energy. The time history of neutron emission coincides with that of nonthermal x-ray emission above 30 keV in a manner consistent with an acceleration model for neutron production. Plasma x radiation below 5 keV corresponds to T_e = 0.4 keV and does not correlate with neutron emission. (auth)

52856 NEUTRON PRODUCTION MECHANISM IN A PLASMA FOCUS. Lee, J. H. (Vanderbilt Univ., Nashville); Shomo, L. P.; Williams, M. D.; Hermansdorfer, H. Phys. Fluids; 14: No. 10, 2217-23(Oct 1971).

The neutrons emitted by a plasma focus were analyzed by using a time-of-flight method. Flight paths as large as 80 m were used to obtain better than 10% energy resolution. The energy spectrum of neutrons from d–d reactions in the plasma focus shows a sharp onset with average maximum energies of 2.8 and 3.2 MeV in the radial and the axial directions, respectively. The average half-width of the energy spectrum was 270 keV with a shot-to-shot variation between 150 and 400 keV. Simultaneous measurements in the axial and radial directions showed no appreciable difference in the half-widths and thus indicated randomly oriented ion velocities in the plasma. A converging ion model is described which is found to be in agreement with the measured quantities. (auth)

52857 NEUTRON ENHANCEMENT FROM RELATIVISTIC ELECTRON BEAM–DENSE PLASMA FOCUS INTERACTIONS. Freiwald, D. A.; Prestwich, K. R.; Kuswa, G. W.; Beckner, E. H. (Sandia Labs., Albuquerque, N. Mex.). Phys. Lett.; 36A: No. 4, 297-8(13 Sep 1971).

A pulsed relativistic electron beam was injected into a dense plasma focus device. With beam–focus coincidence, the emission of neutrons is increased almost five-fold over the average level emitted by the focus device alone. (auth)

Wave Phenomena

52858 (AD–719799) QUANTUM-MECHANICAL STUDY OF PLASMAS. PART II. (APPLICATION OF FLOQUET THEORY TO THE CALCULATION OF RESONANCE FREQUENCIES AND DISPERSION RELATIONS). Final Report. Ashby, Neil; Ross, John (P.E.C. Research Associates, Inc., Louisville, Colo.). Nov 1970. Contract F33615-69-C-1554. 191p. (ARL–70-274). NTIS.

An improved statistical model for electrons in atoms is developed based on an expansion of the one-electron Green's function in spherical harmonics. Improved results in the total energies and electron densities near the nucleus, as compared with the Thomas–Fermi model, are obtained. The model is generalized to include relativistic effects. An improved treatment including retardation effects of surface plasmon dispersion relations, and of the transmission and reflection coefficients for light incident on a semi-infinite plasma, is given. An exact method for solution of a system of coupled differential equations with periodic coefficients is discussed and applied to electromagnetic wave propagation through a gas of spins, and to the Bloch equations for a magnetic moment in an oscillating magnetic field. (auth) (USGRDR)

52859 (KHFTI–70/54) ON THE TRANSFORMATION OF ELECTROMAGNETIC WAVES INTO LONGITUDINAL OSCILLATIONS IN A NONHOMOGENEOUS PLASMA IN THE PRESENCE OF AN IDEALLY CONDUCTING SURFACE. Demchenko, V. V.; Dolgopolov, V. V.; Omel'chenko, A. Ya. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 21p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that electromagnetic waves caused by an initial perturbation at the boundary of a semiinfinite plasma in the presence of an ideally conducting surface transform during a time determined by the width of the transition region from the plasma to the vacuum into longitudinal oscillations concentrated in the transition layer from the plasma to the vacuum and directed along the plasma density gradient. (JPRS)

52860 (KHFTI–70/55) ON THE THEORY OF THE TRANSFORMATION OF SURFACE WAVES INTO LONGITUDINAL OSCILLATIONS IN THE SURFACE LAYER OF A PLASMA WAVEGUIDE. Demchenko, V. V.; Kolgopolov, V. V.; Omel'chenko, A. Ya. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that surface waves caused by an initial perturbation in a homogeneous plasma cylinder transform in a time interval determined by the width of the narrow transition region from the plasma to the vacuum into longitudinal oscillations concentrated in the transition layer from the plasma to the vacuum and directed along the plasma density gradient, along the radius. (JPRS)

52861 (KHFTI–70/57) EFFECT OF HIGH-FREQUENCY POTENTIAL ON THE PROPAGATION OF FAST WAVES ALONG A MAGNETOACTIVE PLASMA LAYER. Demchenko, V. V.; Dolgopolov, V. V.; Omel'chenko, A. Ya. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

The effect of the pressure of an electromagnetic wave field on the propagation of fast waves along a plane-parallel layer of magnetoactive plasma is investigated. Expressions for the fields and dispersion equations in limiting cases when the high-frequency potential is small or great in comparison with the plasma temperature are obtained. The dispersion equations are considerably different from the dispersion equations of linear theory. The plasma density distribution over the thickness of the layer is found. It is shown that a high-frequency potential can ensure penetration into the plasma of an electromagnetic field which, in the linear approximation, does not penetrate the plasma due to skin effect. (JPRS)

52862 (KHFTI–70/58) ON THE EFFECT OF WAVE FIELD PRESSURE ON LONGITUDINAL OSCILLATIONS IN A PLASMA. Dolgopolov, V. V. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

The effect of a high-frequency wave potential (the pressure of the electromagnetic wave field) on standing Langmuir monochromatic oscillations in a plasma is investigated. It is shown that the picture of field oscillations obtained, considering the high-frequency potential, is considerably different from the picture of oscillations obtained in the linear approximation even when the gas-kinetic pressure of the plasma is considerably greater than the electromagnetic field pressure. In particular, localized monochromatic standing waves are possible. (JPRS)

52863 (ORO–3778-6) WAVE PROPAGATION AND DAMPING IN A HOT, BOUNDED PLASMA. Cato, J. E.; Kristiansen, M.; Hagler, M. O. (Texas Tech Univ., Lubbock. Plasma Lab.). 15 Aug 1971. Contract AT(40-1)-3778. 109p. Dep. NTIS.

A theoretical technique is presented that allows numerical investigation of wave propagation on a hot, bounded plasma. In this theory, all dielectric tensor terms are expanded in power series of the hot-plasma-expansion parameter, and at some specified order, all series are truncated. Retaining only zero-order terms yields essentially the cold-plasma theory, while retaining first- or higher-order terms introduces finite temperature corrections. The introduction of these correction terms, however, requires boundary conditions in addition to those on $\overline{E}_t$ and $\overline{H}_t$. When retaining only zero- and first-order terms, one additional boundary condition is required. Assuming a rigid plasma–vacuum boundary, the continuity of the normal electric field is proposed as this additional boundary condition. Numerical results are presented for the fast plasma wave propagating near the second harmonic of the ion cyclotron frequency. Under this condition, finite-temperature effects predict a strong wave-damping mechanism. Since the fast wave is easily excited and propagates at the higher densities, such a damping mechanism may have heating applications for fusion plasmas. This damping mechanism was experimentally investigated; however, the results are not as detailed as were desired because of strong collisional damping in the present system. Further calculations are shown to suggest possible changes in the experiment in order to make this collisional damping less important. (auth)

52864 (SIT-3785-16) INVESTIGATIONS IN PLASMA DYNAMICS. Annual Progress Report. Schmidt, George (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). Jul 1971. Contract AT(30-1)-3785. 8p. Dep. NTIS.

The behavior of weak electrostatic waves in a collisionless magnetoplasma supporting a steady large-amplitude whistler wave was studied. All waves are assumed to propagate parallel to a uniform background magnetic field, B_0. In the presence of the whistler wave fields, each particle executes an oscillatory motion parallel to B_0, in addition to a translation along B_0 and transverse motions. This oscillation causes the Landau resonance to be replaced by a series of new resonances between particles and the electrostatic modes. A distribution function for the perturbed plasma is constructed by solving the Vlasov equation, linearized in the electrostatic-wave amplitudes. A dispersion relation is obtained and solved approximately for the growth/damping rate of the perturbations. Growing electrostatic modes are found to be approximately uncoupled. Trapped particles have a strong influence on the stability of the system. (auth)

52865 EXPERIMENTAL VERIFICATION OF NEGATIVE FARADAY ROTATION. Jones, Donald L. (General Electric Co., Philadelphia). Phys. Rev. Lett.; 27: No. 7, 390-2(16 Aug 1971).

Magneto-ionic theory predicts that positive Faraday rotation, i.e., the direction without collisions, decreases to zero near $\nu/\omega = 1$ and becomes negative for $\nu/\omega > 1$. Using a 35-GHz microwave beam propagating parallel to the magnetic field and the precursor plasma from an exploding wire, rotation of an initially plane wave is measured throughout the region $\nu/\omega \gtrsim 1$. The negative Faraday effect, as well as the crossover from positive to negative with increasing collisions, is qualitively verified. (auth)

52866 RESONANCE ABSORPTION OF MAGNETO-ACOUSTIC WAVES IN A DENSE ARGON PLASMA. Hoegger, B.; Appert, K.; Faessler, K.; Krlin, L.; Schneider, H. (Univ., Freiburg i. B.). Hlev. Phys. Acta; 44: No. 3, 321-44(15 May 1971). (In German).

The heating and energy dissipation of magneto-acoustic waves were calculated and studied experimentally in a cylindrical argon plasma. Optical spectroscopy, laser interferometry, magnetic probes, and diamagnetic loop techniques were used as diagnostics. The maximal temperature increase and energy dissipation were observed under resonant conditions. It turned out that 45% of the available electromagnetic energy was absorbed in the plasma. (auth)

52867 INTERACTIONS BETWEEN ION WAVES AND A HIGH-FREQUENCY ELECTRIC FIELD. Takamura, Shuichi; Aihara, Shuko; Takayama, Kazuo (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 31: No. 3, 925-34(Sep 1971).

The properties of ion waves in a high-frequency electric field are studied. The modification of ion-wave dispersion is obtained when ion waves are excited externally. The frequency shift and suppression of ion wave instabilities are observed. These phenomena are discussed under the new theoretical analysis. (auth)

52868 COUPLING OF ELECTRON AND ION OSCILLATIONS IN THE HOLLOW EFFECT IN A LONGITUDINAL MAGNETIC FIELD. Parvan, Radu; Baianu, Ion (Univ., Bucharest). Rev. Roum. Phys.; 16: No. 5, 521-6(1971).

Experimental data indicate the presence of distinct modes of oscillation in plasma depending on the values of the applied magnetic field intensity, gas pressure, and applied voltage. (auth)

52869 EIKONAL APPROACH TO DRIFT WAVES IN SHEARED FIELDS. Davidson, James N.; Kammash, Terry (Univ. of Michigan, Ann Arbor). Phys. Rev., A; 4: No. 3, 1260-7(Sep 1971).

The stability of drift waves in sheared magnetic fields was studied using two approaches. One method follows a highly localized wave packet that moves across the plasma, and the other solves for the normal modes of oscillation with the boundary condition of outward energy flow. The two methods lead to stability conditions that are virtually identical. An explanation is given for this correspondence, and it is shown that the same results can be obtained by treating the problem by the eikonal approach considering non-normal-mode WKB solutions of the differential equations. (auth)

52870 E-H CYCLOTRON ECHOES IN PLASMA. Bachmann, P.; Sauer, K.; Wallis, G. (Zentralinstitut fuer Elektronenphysik, Berlin). Ann. Phys. (Leipzig); 26: No. 1, 84-8(1971). (In German).

A new echo type with free electrons in a slight inhomogeneous magnetic field excited by one electric and one magnetic pulse is calculated. Thus, features of cyclotron echos and spin echoes are combined. The first electric pulse accelerates all (cold) particles to the same velocity as in the case of usual cyclotron echoes. The second magnetic pulse (at $t = \tau$) rotates the plane of precession in phase space, quite in analogy to the motion of magnetic moments in the case of spin echoes. The echo arises at $t = 2\tau$. The E-H echoes make relaxation and diffusion measurements in plasmas possible, using the methods proved useful in spin-echo technique. There are no complications as in the case of E-E cyclotron echoes, which are based on the fact that a velocity-dependent collision frequency is necessary for the nonlinearity of that echo mechanism. (auth)

52871 BROADENING OF A HIGH-AMPLITUDE MONOCHROMATIC CYCLOTRON WAVE IN A PLASMA. Ivanov, A. A.; Parail, V. V. Zh. Eksp. Teor. Fiz.; 60: No. 6, 2113-21(Jun 1971). (In Russian).

The possibility of broadening of a high-amplitude, initially monochromatic electron cyclotron wave in a plasma is considered. It is shown that as a result of disintegration of such a wave, low-frequency ion-acoustic and high-frequency waves (with a frequency $\omega_r \sim \omega_{He}$) are produced that possess shifted phases and a finite frequency range ($\Delta\omega \leq \omega_{pi}$, where ω_{pi} is the ion plasma frequency). As a result of inverse merging of the waves, cyclotron waves with shifted phases are produced in the same frequency range $\Delta\omega \lesssim \omega_{pi}$. Hence, after a certain time τ, the spectrum of the initially monochromatic cyclotron wave may be broadened to such an extent that quasilinear equations may be employed for solution of the self-consistent problem of plasma electron heating by a cyclotron wave. (auth)

52872 FORMATION OF NONLINEAR WAVES IN THE INTERACTION BETWEEN AN ELECTRON BEAM AND PLASMA. Kovalenko, V. P. (Inst. of Physics, Kiev). Zh. Eksp. Teor. Fiz.; 60: No. 6, 2122-7(Jun 1971). (In Russian).

An approximate analytic solution is obtained for the problem of interaction between a modulated electron beam and plasma in the nonlinear stage up to a wave state close to that of "overturning". It is shown that, along with growth of amplitude, the profile of the traveling wave is strongly deformed, the nature of this distortion being determined by dispersion of the plasma-beam system. It is demonstrated, in particular, that under certain conditions the amplitude of the second harmonic may be greater than that of the fundamental wave. The results agree with experiments on anomalous scattering of a modulated electron beam in a plasma. (auth)

52873 OVERTURNING OF A SIMPLE WAVE IN THE KINETICS OF A RAREFIED PLASMA. Gurevich, A. V.; Pitaevskii, L. P. (Lebedev Inst. of Physics, Moscow. Inst. of Physical Problems, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 6, 2155-74(Jun 1971). (In Russian).

Stability of self-similar solutions of the kinetic equation in a rarefied quasi-neutral plasma is investigated. The existence of a new branch of undamped ion-acoustic oscillations related to the specific form of the self-similar distribution function is demonstrated. The behavior of the solution in the vicinity of a singularity arising on overturning of a simple wave front is investigated. It is shown that if finiteness of the Debye radius is taken into account, an oscillatory structure develops in the plasma behind the overturning point. A class of distribution functions is indicated for which stationary solitary waves (solitons) exist even if allowance is made for thermal motion. In this case an equation of the Korteweg-de Vries type is valid near the overturning point. (auth)

52874 STOCHASTIC KINETIC THEORY OF STRONG WAVE-PLASMA INTERACTION. Di Bona, G.; Masselot, C. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Lett. Nuovo Cim.; 1: No. 26, 1124-6(26 Jun 1971).

The interaction of an electron plasma with a strong electromagnetic wave in which the electrons acquire an energy greater than or equal to their thermal energy is studied. The wave frequency is assumed to be greater than or equal to the plasma frequency. (M.O.W.)

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52875 ANISOTROPY INSTABILITIES OF HYDROMAGNETIC WAVES. Dobrowolny, M.; Rogister, A. (European Space Research Organization, Frascati, Italy). Lett. Nuovo Cim.; 1: No. 26, 1082-4(26 Jun 1971).

A dispersion relation is derived for hydromagnetic waves propagating within a small cone around the direction perpendicular to the ambient magnetic field ($\theta \lesssim m_e/m_i$, m_e and m_i being the electron and ion masses, respectively), for frequencies slightly above the ion cyclotron frequency and wavelengths slightly smaller than the ion Larmor radius. (M.O.W.)

52876 TRANSMISSION OF ELECTROMAGNETIC WAVES THROUGH A CONDUCTING PLASMA SLAB. Wilcox, Ralph M. (Univ. of Southern California, Los Angeles). J. Math. Phys. (N. Y.); 12: No. 7, 1195-1207(Jul 1971).

Some new approaches to the problem of transmission of electromagnetic waves through a finite conducting plasma slab, as formulated by Baraff, are presented. The two-point boundary-value problem for the integro-differential equation of nonlocal wave interaction is reduced to a Cauchy system. It is pointed out that, under circumstances where computational difficulties may be expected to occur with this Cauchy system, a transformation to rotating coordinates will be beneficial. Consequently, a Cauchy system is derived for rotationally transformed equations also. Some alternative approaches are discussed, and an approximate perturbation formula is derived. (auth)

52877 INSTABILITY OF FIXED-PHASE BEAM OF TRANSVERSE WAVES IN NON-LINEAR MEDIA. Demchenko, V. V.; El-Siragy, N. M. (Atomic Energy Establishment, Cairo). Phys. Lett.; 36A: No. 4, 281-2(13 Sep 1971).

The self-effect of nonlinear transverse waves leading to a transformation of their energy over the spectrum of wave numbers is investigated. It is shown that to a certain extent this transformation might be treated as an instability. (auth)

52878 OBSERVATION OF ENHANCED PLASMA WAVES BY LASER SCATTERING. John, P. K.; Irisawa, J.; Ng, K. H. (Univ. of Western Ontario, London). Phys. Lett.; 36A: No. 4, 277-8(13 Sep 1971).

The plasma was produced by a dc discharge in argon whose pressure is 3.1 torr. An acoustic wave was produced by a dynamic speaker on the discharge axis. The phase velocity of the acoustic wave is observed to increase as plasma density. (M.O.W.)

52879 OBSERVATION OF ANOMALOUS SOUND VELOCITY IN WEAKLY IONIZED PLASMA. Ishida, Y.; Idehara, T.; Noda, T. (Fukui Univ., Japan). Phys. Lett.; 36A: No. 4, 273-4 (13 Sep 1971).

An anomalously large sound velocity was observed in weakly ionized Ar plasma. The phase velocity of the acoustic wave increased with increasing plasma density. (M.O.W.)

52880 ION CYCLOTRON WAVES IN A NONUNIFORM CYLINDRICAL PLASMA. Vaclavik, J. (Univ. of Fribourg, Switzerland). Phys. Lett.; 36A: No. 4, 259-60(13 Sep 1971).

The dispersion of the ion-cyclotron waves in a cold cylindrical plasma with a radial gradient of density is investigated. It is shown that, in addition to a discrete spectrum of the axial wave number, a continuous spectrum exists. (auth)

52881 LOW-FREQUENCY OSCILLATIONS OF H^--ION-RICH REFLEX DISCHARGE. Baribaud, M.; Monte, J.; Zadworny, F. (Univ., Grenoble, France). Phys. Lett.; 36A: No. 4, 301-2(13 Sep 1971).

The low-frequency radiation spectrum of a H^--ion rich reflex discharge was studied as a function of outer parameters. When the discharge works at its best as H^- ion source one observes an intense line the frequency of which is linear with the magnetic field. This variation agrees with a theoretical model developed earlier. (auth)

52882 OPTICAL MIXING IN A MAGNETIZED PLASMA. Meyer, J.; Stansfield, B. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 49: No. 16, 2187-93(15 Aug 1971).

The nonlinear interactions of two electromagnetic waves resulting in the excitation of electrostatic oscillations in a magnetized homogeneous plasma are studied. A general expression for the spectral density of the induced fluctuations is derived that includes the effect of the ion motion and an externally applied uniform magnetic field. One basic assumption made is that the frequencies of the electromagnetic waves are much larger than any of the plasma resonance frequencies. Numerical calculations are carried out for the specific case where the induced κ vector is parallel to the external magnetic field, and the results are presented in a series of graphs. The effect of the ion motion for this case is discussed in detail. Some aspects of the case where the induced κ vector is perpendicular to the magnetic field are also discussed. It is found that both—the ion motion and an external magnetic field—can significantly influence the spectral density of the fluctuations. (auth) (Canada)

52883 INFLUENCE OF ELECTRON-ION COLLISIONS ON ION ACOUSTIC WAVES. Stefant, Robert J. (Univ. of California, Berkeley). Phys. Fluids; 14: No. 10, 2245-6 (Oct 1971).

The critical current for the growth of ion acoustic waves in the presence of collisions is calculated by using a kinetic investigation with a collision integral of the Bhatnagar-Gross-Krook type. It is shown that electron-ion collisions facilitate the ion acoustic oscillations. (auth)

52884 BERNSTEIN MODES IN A TWO-DIMENSIONAL COMPUTER PLASMA. Gitomer, S. J. (Univ. of Pennsylvania, Philadelphia). Phys. Fluids; 14: No. 10, 2234-5(Oct 1971).

Stable longitudinal electron waves with $K_{\perp}B$ are studied using a numerical simulation approach. The dispersion properties of these waves agree well with predictions from linear theory. (auth)

52885 NONLINEAR EFFECTS OF TWO TRANSVERSE MONOCHROMATIC WAVES IN A COLD PLASMA. Das, K. P. (Jalpaiguri Government Engineering Coll., West Bengal, India). Phys. Fluids; 14: No. 10, 2235-7(Oct 1971).

The perturbation method of Bogolyubov, Krylov, and Mitropolskii is applied to study the nonlinear effects for two transverse monochromatic waves in a cold plasma. Amplitude-dependent wavelength and frequency shifts, including relativistic corrections, are derived. (auth)

52886 LINEAR CONVERSION OF WAVES FOR OBLIQUE PROPAGATION. Fichet, M.; Fidone, I.; Granata, G. (EURATOM-CEA, Fontenay-aux-Roses, France). Phys. Fluids; 14: No. 10, 2237-9(Oct 1971).

Linear conversion of waves at the upper hybrid resonance for oblique propagation is considered. The conditions for the validity of a fourth-order equation near the resonance are discussed. The cyclotron damping at $\omega \simeq 2\omega_c$ for the converted plasma wave is calculated. (auth)

Shielding

Refer also to abstracts 53494, 53496, 53497, and 54220–54224.

52887 (ORNL-TM-3438) LOW-ENERGY ELECTRON TRANSPORT BY THE METHOD OF DISCRETE ORDINATES. Bartine, D. E.; Alsmiller, R. G. Jr.; Mynatt, F. R.; Engle, W. W. Jr.; Barish, J. (Oak Ridge National Lab., Tenn.). 18 Aug 1971. 103p. Dep. NTIS.

Thesis. Submitted by D. E. Bartine to Univ. of Missouri, Rolla.

The one-dimensional discrete ordinates code ANISN was adapted to simulate the transport of low-energy (on the order of a few MeV) electrons. Two different calculational techniques were utilized for treatment of electron-electron collisions that result in a small energy transfer. One method treats such collisions by a continuous slowing-down approximation, while the other method treats these collisions by the use of a very approximate cross section. Calculated results obtained with ANISM are compared with experimental data for the transmitted energy and angular distributions for 1-, 2.5-, 4-, and 8-MeV electrons normally incident on aluminum slabs of various thicknesses and for 1-MeV electrons normally incident on a gold slab. The calculated and experimental results are in reasonably good agreement for the aluminum slabs but are in poor agreement for the gold slab. Calculated results obtained with ANISN are also compared with calculated results obtained with Monte Carlo methods. (auth)

52888 STOPPING CROSS SECTIONS FOR 0.3- TO 1.7-MeV HELIUM IONS IN SILICON AND SILICON DIOXIDE. Thompson, D. A. (Canadian Westinghouse Co., Ltd., Hamilton, Ont.); Mackintosh, W. D. J. Appl. Phys.; 42: No. 10, 3969-76(Sep 1971).

Stopping cross sections of helium ions with energy 0.3 to 1.7 MeV were measured with a systematic error of ±1.6% in silicon and ±1.3% in amorphous silicon dioxide. The probable random error of the measurements is estimated to be 2.3%. Experimentally, a backscattering technique is used in which the ions are scattered through 150° from a heavy mass atom on the back surface of the target film. The stopping cross-section data were obtained using a 1114-Å-thick silicon target film and a 1030-Å silicon dioxide film. The results for SiO_2 indicate a deviation from the Bragg–Kleeman rule of additivity of atomic stopping cross sections. (auth)

52889 ATOMIC AND MOLECULAR RADIATION PHYSICS. Christophorou, L. G. Wiley Monographs in Chemical Physics. New York; John Wiley and Sons, Inc. (1971). 680p. $29.00.

The subject is dealt with under the following headings: slowing-down in matter of ionizing radiation, total ionization produced in gases by high-energy charged particles, photophysical processes, elastic scattering of low-energy electrons, inelastic electron scattering, negative ions, electron detachment from negative ions and electron affinity of atoms and molecules, heavy neutral- and charged-particle interactions, and biophotophysics and bioelectronics. (UK)

52890 CALCULATIONS OF STOPPING CROSS SECTIONS FOR 0.8- TO 2.0-MeV ALPHA PARTICLES. Rousseau, C. C.; Chu, W. K.; Powers, D. (Baylor Univ., Waco, Texas). Phys. Rev., A; 4: No. 3, 1066-70(Sep 1971).

Calculations of α-particle stopping cross sections based on the theories of Lindhard et al., using the Hartree–Fock–atomic-charge distribution provide generally good agreement with previously obtained experimental results. In particular, the calculations are helpful in understanding the structure that results when, for fixed energy of the α particle, the stopping cross section is plotted against the atomic number of the stopping medium. (auth)

52891 ENERGY LOSS SPECTRA OF LOW-ENERGY ELECTRONS SCATTERED FROM THIN SOLID MOLECULAR FILMS. Merkel, Paul B.; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Chem. Phys.; 55: No. 3, 1409-13(1 Aug 1971).

An electron impact spectrometer designed for measurement of energy-loss spectra of low-energy electrons reflected from thin solid films is described. The spectrometer operates at impact energies as low as 1 eV and is capable of monitoring dynamic changes in electronic excitation cross sections in the important threshold region. Spectra of benzene demonstrate a progression from vibrational excitation through electronic excitation to ionization as the most prominent energy loss mode as incident electron energy is increased. Excitations of benzene to the optically forbidden $^3B_{1u}$ or $^1B_{2u}$ states, while highly probable near threshold, show a rapid falloff in excitation probability at higher impact energies as compared to the optically allowed $^1E_{1u} \leftarrow {}^1A_{1g}$ transition. In studies on 1-hexene, losses involving excitation to the lowest triplet state are also prominent near threshold. (auth)

52892 INVESTIGATION OF THE TRANSMISSION AND ABSORPTION OF BREMSSTRAHLUNG RADIATION IN ALKALI-HALIDE CRYSTALS. Vorob'ev, A. A.; Vorob'ev, V. A.; Zavadovskaya, E. K.; Sokolov, G. P.; Tarasov, G. P. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 11, 129-30(1969). (In Russian).

For transmission and absorption of bremsstrahlung in this work computer calculations were made utilizing the method of statistical sampling. Simultaneous calculations were made of the spectral composition of the radiation flux, average energy of a quantum in the spectrum, the attenuation coefficients, the buildup factors, and the absorbed energy distribution for five layers of material. Calculations were made simultaneously for the irradiation of barriers from an external source with any given energy spectrum and cylindrical symmetry for five irradiation fields of different dimensions; the program permitted calculations for barriers of thickness up to 20 mean free paths. In the whole range of maximum energies of bremsstrahlung (5 to 30 MeV) the laws of distribution of absorbed energy of bremsstrahlung and the energy of emissions of radiant flux from streams have common characteristics. (tr-auth)

52893 PASSAGE OF GAMMA-RAYS THROUGH HETEROGENEOUS MEDIA. Broder, D. L.; Gureev, V. I.; Kozlovskii, S. A. (Physical-Energetics Inst., Obninsk, USSR). Kernenergie; 14: No. 4, 121-4(Apr 1971). (In Russian).

Calculations of gamma-ray streaming through heterogeneous media imply knowledge of effective absorption coefficients and build-up factors for all kinds of shielding. Here, ^{137}Cs and ^{60}Co gamma-ray attenuation functions in water shields containing insertions of variable-diameter steel rods were studied experimentally. With this, spacing between rods was varied. On the basis of gamma-ray doses obtained, semi-empirical relations are proposed, useful for calculating the topography of radiation fields in the case at point or extended (line) sources. (auth)

52894 RADIATIVE TRANSFER IN SPHERICAL SHELL ATMOSPHERES WITH RADIAL SYMMETRY. Ueno, S.; Kagiwada, H.; Kalaba, R. (RAND Corp., Santa Monica, Calif.). J. Math. Phys. (N. Y.); 12: No. 7, 1279-86(Jul 1971).

In recent years, the need to allow for the effect of curvature on the formation of spectral lines has been recognized not only in the fields of planetary and stellar atmospheric physics but also in the field of neutron transport in spherical reactors. Initial-value systems are obtained for the scattering and transmission functions and emergent intensities for inhomogeneous, anisotropically scattering spherical media both with internal and external sources and with various types of cores. (auth)

Solid-State Physics

Refer also to abstract 53729.

52895 PROCEEDINGS OF THE THIRD INTERNATIONAL CONFERENCE ON PHOTOCONDUCTIVITY, STANFORD, CALIFORNIA, AUGUST 12–15, 1969. Pell, Erik M. (ed.). Elmsford, N. Y.; Pergamon Press Inc. (1971). 419p. (CONF-690808).

Sixty-six papers are presented on various topics dealing with the fundamental physics of photoconductive phenomena. The papers are arranged into seven sessions dealing with semiconductors, high-resistivity materials, ionic crystals, ternary compounds, impurities and defects, organic materials and phonon effects, and structures, junctions, and barriers. (D.L.C.)

Radiation Effects

Refer also to abstracts 51903, 52393, 52394, and 52492.

52896 (IFA-SR-1) ESR PARAMETERS ANALYSIS OF OXYGEN COLOR CENTERS IN DOPED NaCl SINGLE CRYSTALS. Nistor, S. V.; Ursu, I. (Institutul de Fizica Atomica, Bucharest (Romania)). [1970]. 21p. Dep. NTIS (U. S. Sales Only).

The dependence of g-tensor components on crystal-field parameters and spin–orbit coupling constants is deduced in the case of a paramagnetic O^- ion situated in a crystal field with axial or orthorhombic symmetry. The calculations were performed on the ^2P term in the approximations $\hat{V}_{cr} \gg \hat{V}_{LS} \gg \hat{V}_h$ and $\hat{V}_{cr} \gg \hat{V}_{LS} \sim \hat{V}_h$, the obtained formulas being used to analyze the ESR parameters of (B) and (C) type of centers earlier observed in doped NaCl single crystals. (auth)

52897 (JPRS-53800, pp 24-8) INFLUENCE OF THE ENERGY SPECTRUM OF A NEUTRON FLUX ON THE SIZE DISTRIBUTION OF DEFECT CLUSTERS. Klimenkov, V. I.; Kirsanov, V. V. Translated from pp 23-6 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

The theory of the effect of neutron energy on defect cluster size is considered with the assumption of an abrupt threshold for cluster formation. Equations are derived for the cross section of cluster formation and the cluster density. The manifestation as volume and electric resistance changes is considered. (D.L.C.)

52898 (JPRS-53800, pp 29-37) CHAINS OF CORRELATED ATOM–ATOM COLLISIONS AND CHARACTERISTICS OF THEIR PROPAGATION. Kirsanov, V. V. Translated from pp 27-34 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A study was made of the characteristics of the propagation of correlated collisions in these crystallographic directions where the focusing influence of the symmetrically arranged neighboring atomic rows plays a substantial role. Calculations were done for a bcc lattice. It is concluded that the chains of correlated collisions pass through several stages (dynamic crowdion and focuson), and that energy is transported along the chain at each stage. (D.L.C.)

52899 (JPRS-53800, pp 44-52) ANISOTROPY OF THE RADIATION DEFECT IN A CRYSTAL LATTICE OF WURTZITE CRYSTALS. Kosenkov, V. M. Translated from pp 38-45 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A model is suggested for radiation damage in the crystal lattice of wurtzite crystals (BeO, ZnO, AlN, and BN). Computations were made for the forces acting from the side of the defects on the lattice. The irradiation of wurtzite crystals may be divided into two stages: (1) An adiabatic injection of the intermediate atoms into the lattice takes place, and the anisotropy is explained by the Coulomb interaction of ions and vacancies. (2) A new type of defect is formed from the displacement of the injected atoms into the trigonal coordination in the base plane. (D.L.C.)

XUM

52900 (JPRS–53800, pp 53-61) ELECTRON PARAMAGNETIC RESONANCE OF COLOR CENTERS IN IRRADIATED POLYCRYSTALLINE BERYLLIUM OXIDE. Sochilin, G. I. Translated from pp 45-52 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A study was made of the properties of the individual EPR lines in neutron-irradiated BeO before and after annealing and supplemental x irradiation. The lines are classified on the basis of the annealing temperature and the temperature dependence of the intensity. The g_1 line belongs to the point defects, while the g_2 and g_3 lines belong to clusters of point defects. The accumulation of a high defect concentration leads to changes in the lines and creation of new defects. (D.L.C.)

52901 (JPRS–53800, pp 62-71) CHANGE IN ELECTRICAL RESISTANCE OF FISSIONABLE MATERIALS DURING IRRADIATION BY NEUTRONS IN LIQUID NITROGEN. Konobeevskii, S. T.; Raetskii, V. M. Translated from pp 52-60 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

A study was made of damage from fission fragments in α-plutonium-239, δ-plutonium-239 – 3 at. % Al, α-uranium, and single crystals of α-uranium. The irradiations were carried out at 77°K, and the electric resistance was measured potentiometrically during the irradiation. With the exception of α-plutonium, the changes were positive. (D.L.C.)

52902 (JPRS–53800, pp 72-8) NEUTRON-DIFFRACTION INVESTIGATION OF THE INFLUENCE OF REACTOR IRRADIATION ON ATOMIC ORDER IN THE ALLOY Ni_3Mn. Lyashchenko, B. G.; Novak, L. I.; Sarksyan, V. V. Translated from pp 61-6 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

The effects of fast-neutron irradiation on the degree of ordering in the initially ordered and disordered Ni_3Mn alloy were studied, using fluences of 3.5×10^{17} to 2.5×10^{20} cm^2 at either <90°C or at 250°C. The neutron-diffraction photographs were taken immediately following irradiation, after prolonged retention at room temperature, and after annealing. The contradiction of the results with theory can be explained if the dislocation density in quenched samples is higher than in the annealed samples. The increase of ordering from irradiation at high temperature is discussed. (D.L.C.)

52903 (JPRS–53800, pp 180-7) QUESTION OF THE DISTRIBUTION OF FISSION FRAGMENTS IN THE LATTICE OF URANIUM DIOXIDE. Vyskubov, V. P.; Lebedev, I. G. Translated from pp 152-7 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

X-ray diffraction was used to study the state of the UO_2 crystal lattice following irradiation at 1000-2000°C before physical deterioration at 8.7 and 9.2 at. % U. Diffractograms are presented, and structural factors are plotted and computed on the assumption that all triply charged ions are injected into the octahedral pores, the Ce and Zr ions replace part of the U, and the local excess positive charge is compensated by the formation of vacancies. The computations agree with the experimental data. It is not known what produces the decrease in the lattice constant. (D.L.C.)

52904 EFFECT OF COLLOIDS ON THE THERMAL CONDUCTIVITY OF γ-IRRADIATED KCl. Guenther, R. A.; Weinstock, H. (Illinois Inst. of Tech., Chicago). J. Appl. Phys. 42: No. 10, 3790-9(Sep 1971).

The influence of γ irradiation at 300 and 77°K on the thermal conductivity of KCl in the range 0.4 to 4°K was investigated. The results are interpreted on the basis of the scattering of phonons by localized defects of both the point and extended varieties. The analysis is consistent with a defect model proposed for irradiated KCl by Sonder et. al. This model postulates the formation of interstitial chlorine atoms which aggregate to form (colloid) clusters whose size and number depend on the irradiation temperature of the crystal. Evidence of aggregates with an effective radius of 70 ± 5 Å has been found for three different single crystals (from two sources of supply) irradiated at 300°K. For a sample crystal irradiated at 77°K and measured after direct cooling to 4°K, there was a significantly larger decrease in conductivity suggesting the possibility of extended defects which disappear after a short annealing period at 300°K. (auth)

52905 THERMAL CONVERSION OF INTERSTITIALS IN ELECTRON-IRRADIATED COPPER. Simpson, H. M.; Sosin, A.; Seiffert, S. L. (Univ. of Utah, Salt Lake City). J. Appl. Phys.; 42: No. 10, 3977-81(Sep 1971).

A study by internal friction measurements was made on high-purity copper of the effects of 1-MeV electron irradiation on the rate of addition of point defects to dislocations in the temperature range 78 to 400°K. A distinct minimum in the point-defect pinning rate is observed at about 160°K. It is also observed that a peak in the decrement as a function of irradiation time occurs, having a peak-position time dependence which reflects the rate at which point defects arrive at dislocations. The above observations are discussed and taken as directed experimental evidence in support of the thermal-conversion model. The maximum in internal friction and the minimum in the pinning rate are accounted for in a model of damping due to the dragging of point defects by dislocations. (auth)

52906 THERMOELECTRIC CURRENTS IN γ-IRRADIATED LUCITE. Murphy, P. H.; Hoecker, F. E. (Univ. of Kansas, Lawrence). J. Appl. Phys.; 42: No. 10, 4094-6(Sep 1971).

Thermoelectric currents were observed in thin lucite disks after exposure to γ radiation. If an electric potential difference is also impressed upon the sample during the heating cycle, the currents are enhanced or depressed depending on the magnitude and polarity of the applied voltage. The measured charge is a linear function of the applied electric field strength, and the field strength necessary to completely suppress the currents appears to be more closely related to the radiation dose than to the temperature gradient in the sample during heating. (auth)

52907 GROWTH OF DEFECT CLUSTERS IN THIN NICKEL FOILS DURING ELECTRON IRRADIATION. II. TEMPERATURE DEPENDENCE OF THE GROWTH RATE OF INTERSTITIAL LOOPS. Urban, K.; Wilkens, M. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Phys. Status Solidi (a); 6: No. 1, 173-85(16 Jul 1971).

The time-independent growth rate 2 w of the diameter of interstitial loops in thin nickel foils irradiated with 650-keV electrons in a high-voltage electron microscope at temperatures between 300 and 630°C is investigated. For the explanation of the temperature dependence of 2 w as observed by Urban (Phys. Stat. Sol., (a) 4: 761(1970)), a simplified diffusion model is introduced and analytically solved under steady-state conditions. In the mode monovacancies are included in addition to interstitials. The attractive interaction of point defects with dislocations is described by effective capture radii that differ for interstitials and vacancies. By fitting to the experimental data of Urban, reasonable values for the radius of the recombination volume of interstitials and vacancies and for the capture radii are obtained. (auth)

52908 HALL STUDY OF SILICON LAYERS DOPED WITH PHOSPHORUS AND BORON BY ION IMPLANTATION. Zorin, E. I.; Pavlov, P. V.; Telebaum, D. I.; Khokhlov, A. F. (Physical-Technical Research Inst., Gorky, USSR). Phys. Status Solidi (a); 6: No. 1, 337-44(16 Jul 1971).

The effective values (i.e., values calculated supposing compensation to be absent) of the ionization energies $E_{a,d}$ of boron and phosphorus introduced into silicon by ion implantation were determined using Hall measurements. At annealing temperatures $\leqq$500°C, E_d for phosphorus exceeds the "normal" values associated with the presence of compensation by acceptor levels of radiation defects. Under the same conditions, the compensation degree is higher for specimens cut out perpendicularly to the [110] axis in comparison with specimens of [111] orientation. For boron in p-type silicon, an increase is found of the effective ionization energy (in comparison with the usual one); E_a first grows with dose (up to 2×10^{14} ions/cm^2) and then decreases. For n-type silicon irradiated with boron, and effective deepening of the level is observed at small doses only and is explained as being due to compensation. An explanation of the mentioned regularities is suggested. (auth)

52909 TEMPERATURE AND ENERGY DEPENDENCES OF AXIAL CHANNELING OF PROTONS IN SILICON CRYSTALS. Fujimoto, F. (Tokyo Univ.); Komaki, K.; Nakayama, H.; Ishii, M. Phys. Status Solidi (a); 6: No. 2, 623-33(16 Aug 1971).

The temperature dependence of the dechanneling coefficient and the minimum yield is studied for $\langle 111 \rangle$ and $\langle 110 \rangle$ axial channeling of 1.0- and 1.5-MeV protons in a silicon crystal. The results show that the dechanneling coefficient is represented by $A\,\rho_\perp^2 + B$, where $\rho_\perp$ is the mean amplitude of thermal vibrations normal to the crystal axis. The minimum yield is represented by $C\,\rho_\perp^2$. The obtained values of A, B, and C are compared with theory. (auth)

52910 SOME OPTICAL PROPERTIES OF COLOR CENTRES IN MANGANESE-DOPED CaF_2 SINGLE CRYSTALS IRRADIATED WITH X RAYS. Agrawal, M. D.; Rao, K. V. (Indian Inst. of Tech., Kharagpur). Phys. Status Solidi (a); 6: No. 2, 693-8(16 Aug 1971).

Results of the following measurements on manganese-doped CaF_2 crystals (with 1 and 5 mol % of manganese content) irradiated with x rays are reported: (i) optical absorption characteristics (in the region 220 to 800 nm) after irradiation at elevated temperatures, (ii) growth of color centers at 30°C with time of irradiation, (iii) bleaching characteristics of colored CaF_2: Mn (5 mol %) with uv light, and (iv) thermoluminescence emission of CaF_2: Mn (5 mol %) as a function of irradiation time. An attempt was made to understand these results. (auth)

52911 V CENTRES PRODUCED IN KBr AND KCl AT 290K BY ELECTRON IRRADIATION. **Clark, C. D.; Newman, D. H. (Univ. of Reading, Eng.). J. Phys., C (London); 4: No. 10, 1130-3(30 Jul 1971).**

Optical absorption techniques were used to study the effects of plastic deformation at 80 and 290°K on V centres in KBr and KCl produced by 2-MeV electron irradiation at 290°K. It is suggested that new V centres present in deformed crystals are associated with halogen interstitials trapped at dislocations (V_x band) and at impurities dispersed during dislocation motion (V_3 band). The V_3 band in KBr and the 6.4 eV band in KCl present in undeformed material decrease during deformation of irradiated crystals. The V_x band appears in two stages on warming after deformation at 80°K. It is proposed that moving dislocations ionize or dissect interstitial defects in their path. The reaction products become mobile at higher temperatures and can diffuse to dislocations to produce V_x absorption. In the range of defect concentrations used in the present work (up to 5×10^{17}F centres cm^{-3}), the induced V centres appear to consist of small numbers of halogen interstitials. (auth) (UK)

52912 ANNEALING OF THE 6060-A COLOR CENTER IN GAMMA-IRRADIATED ANTHRACENE. **Ringel, H. (Queen's Coll., Flushing, N. Y. Brookhaven National Lab., Upton, N. Y.); Damask, A. C.; Arndt, R. A.; Whitten, W. B. Mol. Cryst. Liquid Cryst.; 14: No. 1-2, 63-70(Aug 1971).**

Anthracene crystals irradiated by γ rays exhibit an absorption peak at 6060 Å. Upon annealing, this peak increases and then decreases. When this peak is examined with polarized light, the maximum in the b crystallographic direction is attained before the maximum in the a direction. This is believed to arise from the rotation of a defect. A kinetic scheme, written on this basis, is shown to match the data very well. (auth) (UK)

52913 ESR IN DIAMOND ELECTRON-IRRADIATED AT LOW TEMPERATURE. **Lomer, Jenifer N.; Wild, A. M. A. (Univ. of Reading). Phil. Mag. 24: No. 188, 273-8(Aug 1971).**

The effect of an electron irradiation near helium temperature on the ESR spectrum of type IIa diamond was measured. The unirradiated stones showed a small isotropic line with a g value within 0.2% of the free-spin value. It is known as the "a" line. Marked changes in the intensity of the "a" line occurred during exposure to light and ionizing radiation and during annealing. They can be attributed to charge redistribution. Careful control of the experimental conditions was therefore necessary to establish the intrinsic effect of the low-temperature irradiation. The size of the "a" line remained unchanged during the irradiation at 17°K for doses up to 10^{17} electrons/cm^2. On annealing the diamond to 80°K, the line was enhanced. It decreased to its preirradiation value on annealing to 300°K. Structure was observed at about 60 gauss either side of the "a" line. In one case it was seen during the irradiation at 17°K and appeared to grow linearly with dose. In another case it was only observed after it was enhanced by an anneal to 80°K. This side structure annealed out on heating the diamond to 140°K. It is thought that both the increase in intensity of the "a" line and the side structure arise from defect centres involving the interstitial. The fact that they anneal out is taken as evidence that the interstitial in diamond is mobile below room temperature. (auth) (UK)

52914 ELECTRON SPIN RESONANCE STUDIES OF RADICALS TRAPPED IN LOW-TEMPERATURE MATRICES. **Nelson, William Henry. Durhan, N. C.; Duke Univ. (1970). 96p. University Microfilms Order No. 71-21,548.**

Thesis.

In order to study the electron spin resonance of some simple fluorine-containing radicals, samples of boron trifluoride and phosphorus trifluoride were γ-irradiated at low temperatures. In separate experiments the samples were either in 100% concentration or diluted to 2% concentration in the xenon matrix. From the γ-irradiated BF_3 trapped in xenon at 4.2°K, the BF_2 radical was detected and its structure determined. Isotropic hyperfine splittings due to both B and F were resolved. PF_2 radicals were produced by γ-irradiating PF_3 trapped in xenon. At 77°K an isotropic ESR spectrum was observed by PF_2, while the same sample gave an anisotropic spectrum at 4.2°K. In γ-irradiated solid PF_3 at 4.2°K, PF_4 radicals were detected. The observed spectrum was anisotropic with its structure, indicating two pairs of fluorine atoms having equivalent isotropic couplings. The coupling constants obtained are: $A_{||}(^{31}P) = 1508 \pm 20$ G, $A_{\perp}(^{31}P) = 1328 \pm 20$ G, $a_{iso}(^{31}P) = 1391 \pm 20$ G, $A_{||}(^{19}F)$, 408 ± 10 G, $A_{\perp}(^{19}F) = 366 \pm 10$ G, and $a_{iso}(^{19}F) = 380 \pm 10$ G. Resolution of the hyperfine structure of the second pair of fluorines was not possible, but from the line widths the coupling constants are each estimated to be less than 45 G. From analysis of the coupling data, $F^{(1)}PF^{(1)} = 180°$ and $F^{(2)}PF^{(2)} = 102°$. (Diss. Abstr. Int., B) (TSS)

52915 COLORATION OF $SrCl_2$ SINGLE CRYSTALS BY X RAYS AT LIQUID NITROGEN TEMPERATURE. **Matei, L. (Univ. of Groningen, Netherlands). Solid State Commun.; 9: No. 15, 1281-3(1 Aug 1971).**

Coloration of $SrCl_2$ at low temperature was achieved. The bands displayed by the optical spectrum are interpreted as corresponding to F-centers, M-centers, and interstitial chlorines. (auth) (UK)

52916 EFFECT OF CHANNELING ON POSITRON BACKSCATTERING FROM CRYSTALS. **Vorobev, A. A.; Didenko, A. N.; Vorobev, S. A.; Tsekhanovskii, I. A. (Tomsk Polytechnic Inst., USSR). Phys. Status Solidi (a); 6: No. 2, 389-93(16 Aug 1971).**

The dependence of the positron backscattering counting rate on the orientation angle of KCl, KBr, and KI single crystals relative to the incident beam axis is investigated. In the case where the initial positron beam was coincident with the ⟨100⟩ crystallographic axis, a dip in yield for backscattered positrons was observed. In comparison with positron measurements, the backscattered electrons show a peak in yield. The minimum for positrons and the maximum for electrons disappeared in crystals heated up to about 800°K. (auth)

52917 ELECTRON IRRADIATION EFFECTS IN SILICON AT LIQUID HELIUM TEMPERATURES USING AC HOPPING CONDUCTIVITY. **McKeighen, Ronald Eugene. Urbana, Ill.; Univ. of Illinois (1971). 132p. University Microfilms Order No. 71-21,180.**

Thesis.

Changes in ac hopping conductivity with electron irradiation were measured in n-type, p-type, and high-purity silicon. Irradiations were carried out at both 5.0 and 1.6°K, with measurements made at reference temperatures of 4.2 and 1.3°K, respectively. In the p-type crystals, the changes in ac hopping conductivity depended strongly on the concentration of chemical acceptors, indicating a concentration dependence on impurities in the defect production rate. The production rates at 1.6°K were generally very similar to those for a 5.0°K irradiation. No significant thermal annealing stages below room temperature were observed in any of the crystals. A small amount of "reverse annealing," i.e., an increase in ac hopping conductivity was observed below 30°K. No radiation annealing effects due to a beam of either 0.500- or 0.350-MeV electrons were observed, either at 4.5°K or at 1.45°K. (Diss. Abstr. Int., B)

52918 TYPE CONVERSION IN CdS BY ION IMPLANTATION OF BISMUTH. **Eldridge, Graeme Willard. Boulder, Colo.; Univ. of Colorado (1970). 278p. University Microfilms Order No. 7-21,582.**

Thesis.

CdS is normally n-type and cannot be type-converted by conventional means; the objective of this work was to investigate type conversion by ion implantation. Single-crystal CdS was implanted at room temperature with 25-keV Bi to doses between $3 \times 10^{15}/cm^2$ and $8 \times 10^{16}/cm^2$. Post-implantation annealing was not employed. Layers implanted on high-resistivity CdS exhibit high conductivity and p-type Hall and thermal probe signals. HEED studies indicate that the extent of bombardment damage is unusually low and that the implanted layers are single-crystal CdS even at high doses; this result can be associated with efficient sputtering. Radiotracer studies indicate Bi penetration to 3500 Å; the range distribution suggests that amorphous stopping, channeling, and diffusion play a role in the penetration. Sputtering is also an important process in determining the Bi concentration as a function of depth. Diodes were prepared by implantation of high-conductivity CdS. These implanted layers also exhibit high-conductivity and p-type thermal probe signals. The diodes exhibit a 2.4 ± 0.1 volt forward turnover voltage and the correct polarity for a p–n junction. Forward biased junctions emit green light at room temperature and below. This emission can be associated with recombination of holes injected into the n-type bulk. (Diss. Abstr. Int., B)

XUM

52919 ELECTRICAL PROPERTIES OF SILICON DIODE ARRAY CAMERA TARGETS MADE BY BORON ION IMPLANTATION. Pickar, K. A. (Bell Telephone Labs., Murray Hill, N. J.); Dalton, J. V.; Seidel, H. D.; Mathews, J. R. Appl. Phys. Lett.; 19: No. 2, 43-4(15 Jul 1971).

Silicon diode targets used as the image-sensing element of video camera tubes have been successfully fabricated with one photolithographic step using boron-ion implantation to form the array of ~800,000 p^+n diodes. Targets were made reproducibly in this way with total leakage currents $\lesssim$10 nA at 12-V bias and 0 to 2 low-intensity white video defects per target. The results, which are insensitive to changes in dose and energy, show that heavily boron-implanted oxides can be annealed to give low-surface recombination velocity ($S_0 \sim 7$ cm/sec) and fixed charge ($Q_{ss}/q \simeq 2.0 \times 10^{11}$ cm^{-2}). In addition, the bulk effective lifetime in the space-charge region of the implanted diodes is measured to be $\tau > 200$ μsec. (auth)

52920 HOLE DRIFT MOBILITY IN N-TYPE GERMANIUM IRRADIATED BY FAST NEUTRONS. Yeh, Ta Hai. Lexington, Ky.; Univ. of Kentucky (1970). 153p. University Microfilms Order No. 71-19,402.

Thesis.

A model developed by Crawford, Cleland, and Gossick in 1959 proposes that, in n-type germanium, neutron irradiation forms small highly p-type regions in the n-type matrix. The p region is surrounded by a space-charge zone, which shields it from the outside n-type lattice. The potential well thus formed suppresses majority-carrier current and at the same time may, or may not, enhance minority carrier current depending on the extent of trapping by damage regions. The study was made to explore the behavior of minority carriers and to determine how this behavior is influenced by the presence of disordered regions. Measurements were made of the hole drift mobility and dc resistivity versus temperature in n-type germanium subjected to successive monoenergetic neutron irradiations. Material studied ranged from 1 to 16 ohm-cm; the temperature range covered was from 77 to 300°K; the energies of neutrons used for irradiation were 14 and 1 MeV; and the total neutron flux of irradiation was about 3×10^{12} n/cm^2. A modified version of the Haynes–Shockley experiment was developed and employed for the drift-mobility measurement. Results of measurements made on n-type germanium irradiated with 14-MeV neutrons indicate that dc resistivity increases with irradiation in accord with the prediction of the theory of the disordered-region model, whereas the hole drift mobility shows a uniform monotonic decrease with irradiation, contrary to preliminary experimental studies and theoretical calculations in which trapping was neglected. There is clear evidence of the introduction of high concentration of trapping centers by neutron irradiations and the trapping effects are thought to be responsible for the decrease in hole drift mobility. The disordered-region model is extended in order to account for minority carrier behavior. Trapping states within the regions are considered, and a semiquantitative expression is presented for the drift mobility of minority carriers in neutron-irradiated semiconductors. The expression includes the effects of two competing processes, viz., the dipolar diffusion process due to the presence of the disordered regions and the trapping process due to the trapping states within the regions. The expression gives a qualitative explanation to the experimental observations obtained. (Diss. Abstr. Int., B.) (TSS)

52921 DEFERRED LUMINESCENCE AT 4.2K IN AN ORGANIC GLASS. Kieffer, F.; Magat, M.; Meyer, C.; Rigaut, J. (Univ. de Paris-Sud, Orsay, France). Nature (London) Phys. Sci.; 232: No. 32, 130(9 Aug 1971).

Deferred luminescence was observed at 4.2°K from methylcyclohexane glass containing biphenyl (10^{-4} to 10^{-2} mol. dm^3) after irradiation with γ rays to a dose of 30 kR at 60 kR/hr in liquid He. This was not due to residual N_2, but was attributed to tunnelling of electrons trapped very near the cations, probably at a distance <15Å. Measurements of the decay kinetics and the influence of the matrix are in progress. (UK)

52922 SATURATION VALUES OF NOBLE GAS IONS IN POLYCRYSTALLINE C, Al, Ti, AND Cu BACKINGS IN THE keV ENERGY REGION. Arminen, E.; Fontell, A. (Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI; No. 357, 1-13 (1971).

Polycrystalline graphite, aluminum, titanium, and copper were bombarded with Ne, Ar, Kr, and Xe ions in an electromagnetic isotope separator. The quantities of gases collected at saturation as a function of the ion energy were measured in the energy region from 1 to 120 keV by the elastic backscattering of 1.8-MeV He$^+$ ions. At high energies, the maximum concentrations of the implanted noble gas atoms were calculated from the backscattering spectra. In the case of the low-sputtering materials, graphite, aluminum, and titanium, all the measurable number concentrations were of the same order of magnitude. In copper, a high-sputtering material, both the quantities collected and the concentrations were considerably lower. (auth) (Finland)

52923 STUDIES OF REPEATED PHOSPHORESCENCE AND DETERMINATION OF ELECTRON CAPTURE IN ALKALI-HALIDE PHOSPHORS ACTIVATED BY Eu^{2+}. Parfianovich, I. A.; Yarovoi, P. N. (Irkutsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 105-7(1970). (In Russian).

Flare-up and damping of photostimulated luminescence in a series of x-irradiated alkali-metal-halide crystal phosphors activated by Eu^{2+} in the millisecond–second ranges were analyzed. The stimulation took place in the F-absorption band region, and the luminosity of the activated luminescence center was recorded. Phosphors of KI: Eu, KBr: Eu, KCl: Eu, and NaCl: Eu (all with 0.1 mol % Eu) were studied. Data obtained showed for the KI: Eu specimen two time-lag intervals related to two depth levels of electron capture, one at 100 to 125°K and the other at 180 to 230°K. The studies also indicated three intervals for KBr: Eu at 90 to 290°K, two for KCl: Eu at 120 to 140°K and 205 to 245°K, and one for NaCl: Eu at 360 to 420°K. (R.V.J.)

52924 EFFECT OF IONIZING RADIATION AND Sr^{2+} CONCENTRATION ON HARDENING OF KCl CRYSTALS. II. Suszynska, M.; Pozniak, J. (Inst. of Low Temperature and Structure Research, Wroclaw). Phys. Status Solidi (a); 6: No. 1, 79-86 (16 Jul 1971).

Using KCl crystals doped with Sr^{2+}, the influence of admixture concentration, x-irradiation, and quenching from higher temperature on microhardness is examined. Additionally, the electric conductivity of "as received" or plastically deformed crystals is measured. The results suggest the existence of a characteristic concentration range of Sr^{2+} up to ≈80 ppM, ascribed to the prevailing contribution of simple dipoles. The other characteristic concentration range is that up to ≈200 ppM, where the presence of small dipole aggregates seems to predominate. The obtained results show that the microhardness measurements yield reliable information on the behavior of the impurity ions in the host lattice. (auth)

52925 EFFECT OF IONIZING RADIATION AND Sr^{2+} CONCENTRATION ON HARDENING OF KCl CRYSTALS. III. Suszynska, M. (Inst. of Low Temperature and Structure Research, Wroclaw). Phys. Status Solidi (a); 6: No. 1, 87-90(16 Jul 1971).

The effect of Sr^{2+} concentration on the critical resolved shear stress of KCl crystals is examined. The empirical relationship $\sigma_0 \sim c_{Sr}^{0.6}$ and the concentration range of its validity imply that, in the hardening, both impurity dipoles and small dipole aggregates are involved. It is expected that the interaction between dislocations themselves is responsible for the low value of the hardening parameter (0.1 G). A simple relationship between critical resolved shear stress and microhardness is obtained. The results are in good agreement with those published in the previous parts. (auth)

52926 POLARIZATION OF CHANNELED DEUTERONS. Kaminsky, M. (Argonne National Lab., Ill.). pp 803-9 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

52927 NUCLEATION OF VOIDS IN MATERIALS SUPERSATURATED WITH VACANCIES AND INTERSTITIALS. Latz, Joseph L. (Clarkson Coll. of Tech., Potsdam, N. Y.); Wiedersich, Hartmut. J. Chem. Phys.; 55: No. 3, 1414-25(1 Aug 1971).

High-energy radiation simultaneously produces vacancies and interstitials in crystalline materials and, therefore, both types of defects are supersaturated during irradiation. The nucleation of defect precipitates under this circumstance is fundamentally different from the usual nucleation problem because of the competing effects of interstitials and vacancies on the size distribution of precipitate embryos. The rate of homogeneous nucleation of voids in such a material in which interstitials as well as vacancies are supersaturated is derived. It is shown that the thermodynamically derivable void embryo size distribution $n^0(x)$ (that is, the distribution which is in equilibrium with a given vacancy supersaturation) is in equilibrium with interstitials only when the latter are in equilibrium with the vacancies, i.e., when the interstitials are undersaturated to the same extent as the vacancies are supersaturated. The constrained distribution of voids $n(x)$ (that is, when the interstitials are also supersaturated) is determined by the kinetics of incorporation of vacancies and interstitials into the embryos. Explicit expressions are given for n(x) in terms of kinetic parameters and $n^0(x)$. The rate of nucleation is then derived from n(x) along the lines of classical nucleation theory. The procedure developed here can readily be applied to the nucleation of other types of defect precipitates such as dislocation loops. A useful parameter to characterize the effect of excess interstitials on the nucleation of voids is the ratio of the rates at which interstitials and vacancies arrive at and are incorporated into void embryos. At a constant vacancy supersaturation, as this arrival rate ratio increases from essentially zero (i.e., interstitials in equilibrium with vacancies) the nucleation rate decreases and the size of the critical nucleus increases. Thus, to obtain a given rate of nucleation, increasingly larger supersaturations are required as the arrival rate ratio increases. The calculated changes are gradual at lower values of this ratio but become so drastic as the ratio approaches one that no nucleation of voids is then possible. As in classical nucleation theory, the rate of nucleation increases very rapidly with increases in supersaturation. This rapid increase of rate is obtained for all arrival rate ratios. It is found that the supersaturations of defects which occur during irradiation in a high flux of energetic neutrons or ions are sufficient for readily observable nucleation rates for voids at intermediate temperatures but insufficient at high temperatures. (auth)

52928 ESR STUDIES OF AN INTRINSIC TRAPPED-ELECTRON CENTER IN X-IRRADIATED ALKALI BORATE GLASSES. Griscom, D. L. (Naval Research Lab., Washington, D. C.). J. Chem. Phys.; 55: No. 3, 1113-22(1 Aug 1971).

Electron spin resonance studies were carried out at X-band frequencies on a large number of glasses spanning the lithium, sodium, and potassium borate glass systems, following x irradiation at cryogenic temperatures (T ~ 25 or ~77°K). A new, intrinsic paramagnetic defect center characterized by a sizeable hyperfine interaction with boron [A (^{11}B) ~100 G] was observed in addition to the more familiar boron–oxygen hole centers. The new center, which is readily destroyed by visible light or thermal annealing above ~100°K, is shown to be of the trapped-electron type. By means of computer simulations of the spectra, a reasonably complete set of spin–Hamiltonian parameters is derived in spite of the obscuring effects of a substantial distribution in hyperfine coupling constants. Possible models for the new defect are considered and its potential usefulness as a "probe" of the structure of alkali borate glasses is discussed. (auth)

52929 INFLUENCE OF RADIATION DAMAGE ON HYPERFINE-INTERACTION MEASUREMENTS AFTER IMPLANTATION IN METALS. Bernas, H.; Ruault, M. O.; Jouffrey, B. (Faculte des Sciences, Orsay, France). Phys. Rev. Lett.; 27: No. 13, 859-62 (27 Sep 1971).

Electron microscopy experiments are reported showing that the spatial distribution of damage produced in metals by implanted ions is generally quite different from that of the ions themselves. A discussion is given of how this affects hyperfine-interaction measurements. (auth)

52930 EFFECT OF PILE-NEUTRON IRRADIATION ON THE DIELECTRIC PROPERTIES OF $PbZrO_3$. Hilczer, B.; Kulek, J. (Inst. of Physics, Poznan, Poland). Acta Phys. Pol.; A40: No. 2, 229-37(Aug 1971).

Ferroelectric and antiferroelectric properties are very sensitive to crystal-lattice defects. The influence of defects engendered by pile-neutron irradiation in $PbZrO_3$ is studied. The antiferroelectric Curie temperature was found to be shifted towards lower temperatures and the thermal hysteresis of dielectric permittivity was found to increase. Moreover, the dielectric polarization measured from the hysteresis loop in the vicinity of the phase-transition temperature was found to decrease due to neutron irradiation, and the temperature range in which the hysteresis loop appears became narrower. (auth)

52931 RECOMBINATION LUMINESCENCE IN γ-IRRADIATED 3-METHYLPENTANE GLASS AT 77°K. Sawai, Teruko (Tokyo Metropolitan Isotope Research Center). J. Nucl. Sci. Technol. (Tokyo); 8: No. 8, 431-7(Aug 1971).

Thermoluminescence from γ-irradiated 3-methylpentane at 77°K has been studied. Two kinds of emission spectra are observed in the visible region according to temperature. The one has its maximum intensity at 425 nm and is observed in the temperature range of 77° to 83°K (Spectrum I), the other its maximum at 530 nm, appearing at 83° to 90°K (Spectrum II). The effects brought upon the integrated luminescence intensity by differences in radiation dose, by ir and uv bleaching, by the addition of electron or hole scavengers, and by standing in dark were examined, and the results are compared with those obtained from optical absorption in the ir and uv regions under various experimental conditions. The results suggest that the spectrum I is caused by the recombination of positive holes with electrons released by the warming, while the spectrum II would appear attributable to the recombination of positive holes with some anionic species produced by the reaction of electrons with radicals. (auth)

Physical Properties

Refer also to abstracts 51475, 52326, 52446, 52451, 52479, and 52753.

52932 (CONF-711001-(Vol.1)) PROCEEDINGS OF THE 9th RARE EARTH RESEARCH CONFERENCE [HELD IN BLACKSBURG, VIRGINIA], OCTOBER 10–14, 1971. Field, P. E. (ed.) (Virginia Polytechnic Inst. and State Univ., Blacksburg). 442p. Dep. NTIS.

Thirty-nine papers and nine abstracts are included, which were presented in sessions A through H dealing with solid state, chemistry, preparation and properties, magnetics, Moessbauer spectroscopy, biochemistry, and metallurgy. Separate abstracts were prepared for 24 of the papers. (D.L.C.)

For abstracts of individual papers see: 51423, 51424, 51466–51469, 51572, 52297, 52320, 52372–52375, 52605–52607, 52933–52939, and 52971.

52933 (CONF-711001-(Vol.1), pp 200-7) MAGNETISM IN THE RARE EARTH METALS. A REVIEW. Elliott, R. J. (Oxford Univ. (England). Dept. of Theoretical Physics). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The magnetic properties of the pure rare-earth metals are examined on how far they may be interpreted on the basis of simple phenomenological theories. Exchange, crystal field, and magnetoelastic coupling are discussed in turn. (25 references) (D.L.C.)

52934 (CONF-711001-(Vol.1), pp 208-17) STUDY OF THE TRANSITION-METAL MOMENT IN THE SYSTEMS $Gd(Co_{1-x}Ni_x)_3$ AND $Gd(Fe_{1-x}Ni_x)_3$. Greedan, J. E. (Pittsburgh Univ., Pa. Dept. of Chemistry). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The pseudo-binary solid solutions $Gd(Co_{1-x}Ni_x)_3$ and $Gd(Fe_{1-x}Ni_x)_3$ were investigated with respect to their bulk magnetic properties. X-ray structural studies indicate that the $PuNi_3$-structure type obtains throughout the entire composition range. All members except $GdNi_3$ are ferrimagnetic, with the total transition-metal moment aligned opposite to that of gadolinium. Assuming that the magnetic moment of gadolinium is fully 7 μ_B at 4.2°K and infinite field, the total transition-metal moment can be evaluated for each member of the solid solution. The transition metal moment obtained in such a way is plotted against the transition-metal electron concentration. In the case of $Gd(Co_{1-x}Ni_x)_3$, the moment varies linearly from 1.4 μ_B at $x = 0$ ($GdCo_3$) to zero at $x = 1$ ($GdNi_3$) while for $Gd(Fe_{1-x}Ni_x)_3$ this moment varies in a decidedly nonlinear manner from 1.8 μ_B at $x = 0$ ($GdFe_3$) again to zero at $x = 1$. These results cannot be rationalized on the basis of a rigid band model for the transition-metal electrons. (auth)

52935 (CONF-711001-(Vol.1), pp 218-28) MAGNETIC PROPERTIES OF $RT'_{3-x}T''_x$ (R = Dy OR Ho AND T′ = Fe OR Co AND T″ = Ni). Narasimhan, K. S. V. L.; Butera, R. A.; Craig, R. S. (Pittsburgh Univ., Pa. Dept. of Chemistry). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The effect of varying electron concentration on the magnetic ordering in the ternary intermetallic compounds $DyCo_{3-x}Ni_x$, $DyFe_{3-x}Ni_x$, $HoCo_{3-x}Ni_x$, and $HoFe_{3-x}Ni_x$ with $0 < x < 3$ was investigated by saturation magnetization studies. The results show filling of the Co and Fe band and polarization of the Sd band of nickel. In the case of the Co compounds, additional contribution from the induced moment on cobalt by the rare-earth exchange field is found to be important. (auth)

52936 (CONF-711001-(Vol.1), pp 229-39) PULSED FIELD MAGNETIZATION MEASUREMENTS IN RARE EARTH-TRANSITION METAL COMPOUNDS. Primavesi, G. J.; Taylor, K. N. R. (Durham Univ. (England). Dept. of Physics). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Magnetization measurements were performed in a variety of rare earth–transition metal compounds. These resulted in the observation of critical-field behavior in many compounds, in some cases for compounds which show normal ferromagnetic behavior in static fields. (auth)

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52937 (CONF-711001–(Vol.1), pp 240–240k) STRUCTURAL, MAGNETIC, AND ELECTRICAL PROPERTIES OF DYSPROSIUM–NEODYMIUM ALLOYS. Krizkova, H.; Chatterjee, D.; Taylor, K. N. R. (Durham Univ. (England). Dept. of Physics). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The room-temperature lattice parameters of a series of alloys in the Dy–Nd system have been measured. Magnetization in static and pulsed fields and electrical resistivity measurements were made between 4.2 and 300°K. The hcp alloys show a two-step ordering while the Sm-type alloys have one ordering temperature. The dhcp alloys do not show any magnetic ordering. The spin-disorder resistivity and the Neel temperatures show a smooth variation with a reduced de Gennes function ($\bar{G}$) given by $xG_1-(1-x) G_2$, where x is the fractional dysprosium concentration and G_1 and G_2, the de Gennes functions for dysprosium and neodymium respectively. (auth)

52938 (CONF-711001–(Vol.1), pp 242–51) EFFECT OF COMPOSITION ON THE MAGNETIC PROPERTIES OF Sm–Co ALLOYS. Walkiewicz, J. W.; Winston, J. S.; Wong, M. M. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Magnetic measurements of a number of Sm–Co intermetallic compositions were made. Results of this investigation indicated that the composition with optimum magnetic properties was 37.4 wt % Sm and 62.2 wt % Co. This as-melted alloy consisted of two phases in a proportion of 3 parts Sm_2Co_7 and 4 parts $SmCo_5$. Highest values attained with this composition were $_MH_c$ = 18.9 kOe, $_BH_c$ = 6,160 Oe, B_r = 6,640 G, and $(BH)_{max}$ = 10.1 MGOe. The optimum sintering time and temperature were determined, and the effects of composition on particle size and sintered density are discussed. (auth)

52939 (CONF-711001–(Vol.1), pp 252–60) LIQUID-PHASE SINTERING OF $PrCo_5$ MAGNETS WITH A Sm–Co ADDITIVE. Strnat, K. J.; Tsui, J. B. Y.; Schweizer, J. (Dayton Univ., Ohio). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

A study was made of the liquid-phase sintering of $PrCo_5$ with 60% Sm–40% Co additive and of the parameters affecting the coercive force, remanence, energy product, and density. The parameters studied were grinding time, weight ratio of base metal to sintering aid, sintering temperature and time. Maximum energy product was ~21 MGOe and $_MH_c$ ~14,000 Oe. (D.L.C.)

52940 (CONF-711001–(Vol.2)) PROCEEDINGS OF THE 9th RARE EARTH RESEARCH CONFERENCE [HELD IN BLACKSBURG, VIRGINIA], OCTOBER 10–14, 1971. Field, P. E. (ed.) (Virginia Polytechnic Inst. and State Univ., Blacksburg). 407p. Dep. NTIS.

Thirty-four papers and five abstracts are included from Sessions I through N, which dealt with spectroscopy, biochemistry, chemistry, metallurgy, and solid state. Separate abstracts were prepared for 20 of the papers. (D.L.C.)

For abstracts of individual papers see: 51470, 51471, 51508, 51969, 52304, 52305, 52321, 52376, 52377, 52453–52456, and 52941–52947.

52941 (CONF-711001–(Vol.2), pp 452–64) FLAME EXCITED LUMINESCENCE IN TERBIUM AND EUROPIUM DOPED RARE EARTH OXIDES. Sweet, John R.; White, William B. (Pennsylvania State Univ., University Park. Materials Research Lab.). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Luminescence from Y_2O_3, Gd_2O_3, and Lu_2O_3 doped with ~0.1% Eu^{3+} and Tb^{3+} is activated by a hydrogen diffusion flame. The flame-excited luminescence spectra are similar to those known for photoluminescence from the same activators, but lower concentrations of the activator ions are required than for photoluminescence. The luminescence exhibits a marked temperature dependence. A typical plot of intensity vs temperature is a bell-shaped curve with a peak at 100°C or higher, depending on the particular activator/host system. Activation appears to be by neutral OH* species in the flame. A similar luminescence can be produced by bombarding the phosphor with particles produced by passing water vapor through a microwave cavity. (auth)

52942 (CONF-711001–(Vol.2), pp 465–77) TWO-PHOTON SPECTROSCOPY: RARE EARTH AND ACTINIDE IONS IN SINGLE CRYSTALS. Gruber, John B. (Washington State Univ., Pullman. Dept. of Physics). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Two-photon absorption was used as a means of stimulating emission from rare earth and actinide ions in sites of inversion symmetry in single crystals of RE_2O_3, $RE^{3+}: Y_2O_3$, $RE^{4+}: ThO_2$, and $RE^{2+}: CaF_2$. A pulsed ruby laser together with an intense incoherent light source were used in many of the two-photon experiments. In certain cases, an intense band at twice the frequency of the laser resulted in ultraviolet sharp line emission. To explain the results for both absorption and emission, probability amplitudes are derived for various two-photon processes, and a new method is given for evaluation of the infinite sum that appears. Two-photon spectroscopy is particularly suited to studying $nf^n \rightarrow nf^n$ transitions since two-photon absorption matrix elements in the electric dipole approximation achieve their maximum probability between states of the same parity. (auth)

52943 (CONF-711001–(Vol.2), pp 478–87) SPECTRA AND ENERGY LEVELS OF Eu^{3+} IN $LnLiO_2$ COMPOUNDS. Gaume-Mahn, F.; Linares, C.; Blanchard, M. (Lyon Univ. (France)). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Europium luminescence was studied in the lithium and rare-earth mixed oxides $LnLiO_2$ (L = Sc, Lu, Y, and Gd). In these compounds, the structure depends on the rare-earth ion radius. Thus, the symmetry site of Eu^{3+} is tetragonal D_{2d} in $ScLiO_2$ and $LuLiO_2$, triclinic C_1 in the more stable form of $YLiO_2$, monoclinic C_s in $GdLiO_2$. From the excitation and emission spectra, the energy levels of the ^7F_J ground multiplet (J = 0, 1, 2, 3, 4) and of the ^5D_J excited states (J = 0, 1, 2) were determined. The number of the lines corresponding to each $^5D_J \rightarrow {}^7F_J$ transition is studied in connection with the symmetry site. The $^5D_0 \rightarrow {}^7F_2$ transition corresponds to the most intense lines. Their positions and intensities are consistent with the irreducible representations corresponding to the $^5D_0$ and $^7F_2$ states and the selection rules in the D_{2d}, C_1, and C_s symmetries. Moreover, a comparison between the energies of the Eu^{3+} levels in various compounds suggests a covalency of the Ln–O bond in $LnLiO_2$. (auth)

52944 (CONF-711001–(Vol.2), pp 668–78) LOW TEMPERATURE HEAT CAPACITY OF RARE EARTH INTERMETALLIC COMPOUNDS. Gschneidner, Karl A. Jr. (Iowa State Univ. of Science and Technology, Ames). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The various contributions to the low-temperature (1 to 20°K) heat capacity of solids are discussed, as pertains to intermetallic compounds. Although only a limited number of rare earth intermetallics have been investigated, several interesting observations are commented on. Some problems concerning the interpretation of the results are also noted. (auth)

52945 (CONF-711001-(Vol. 2), pp 680–91) STUDIES OF KONDO PHENOMENON IN $Ce_xLa_{1-x}Pd_3$ TERNARY ALLOYS. Hutchens, R. D.; Rao, V. U. S.; Greedan, J. E.; Craig, R. S. (Pittsburgh Univ., Pa. Dept. of Chemistry). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The electrical resistivities of the cubic $Ce_xLa_{1-x}Pd_3$ ternary alloys were measured from 2 to 300°K. The alloys were found to consist of single phases except in the region $0.3 < x < 0.5$. The resistivities indicated the presence of the Kondo phenomenon in all the alloys containing cerium. In some alloys, a maximum in the resistivity–temperature curve was found and also an additional minimum at low temperatures. This behavior is interpreted as arising because of the influence of the cubic crystalline field on the cerium ions. The heat capacity of the alloys with x = 1.0, 0.8, 0.25, 0.2, 0.1, 0.05, and 0.0 was measured in the temperature range 1.5 to 10°K. For the compositions x = 1.0 and 0.8, the equation $C = \gamma T + \beta T^3$ was found to be valid and yielded a high value for γ. The heat capacities for the remaining compositions showed marked deviations from this simple relation, and exhibited well-defined minima in the C/T vs T^2 curves in some cases. The significance of these results is discussed in terms of a model for the electronic structure proposed. (auth)

52946 (CONF-711001–(Vol.2), pp 692–703) ELECTRICAL RESISTIVITIES OF SOME PALLADIUM–RARE EARTH INTERMETALLIC COMPOUNDS. Elliott, R. O.; Hill, H. H. (Los Alamos Scientific Lab., N. Mex.). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

The electrical resistivity as a function of temperature between 1.5 and 300°K was measured for the intermetallic compounds PdCe and Pd_3X, where X = Sc, Y, La, Ce, Pr, Nd, Sm, Eu, Yb, and Lu. Normal resistive behavior was observed in Pd_3Sc, Pd_3Eu, Pd_3Yb, and Pd_3Lu. Behavior indicative of magnetic ordering at low temperatures was observed in PdCe, and perhaps also in Pd_3Pr and

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Pd_3Sm. Weak resistive minima were observed in Pd_3Y, Pd_3Nd, and perhaps Pd_3La. The origin of the minima is not known with certainty; impurity effects are a possibility. Pd_3Ce exhibited a negative temperature coefficient of resistivity at room temperature. Below room temperature, the resistivity of the alloy rose gradually with decreasing temperature to a maximum value at ~113°K and then decreased relatively rapidly to a residual value at ~4°K. There is no obvious indication of magnetic ordering in the alloy. (auth)

52947 (CONF-711001-(Vol.2), pp 713-23) ANISOTROPY OF EXCHANGE AND ITS VARIATION WITH LATTICE PARAMETERS FOR RARE EARTHS IN THE PARAMAGNETIC STATE. **Boutron, P.; Feron, J. L.; Hug, G.; Morin, P. (Centre National de la Recherche Scientifique, Grenoble (France). Laboratoire d'Electrostatique et Physique du Metal). 1971.**

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

Exchange anisotropy of rare earths is obtained by interpreting the anisotropy of the variation of the paramagnetic susceptibility in a high magnetic field. The variation of this anisotropic exchange with the lattice parameters is deduced from the paramagnetic magnetostriction. The variation of the susceptibility in a high magnetic field was measured for dysprosium. Subtracting the contribution due to magnetostriction, it was found that the anisotropy of exchange is important. The derivatives of the exchange energy with respect to the lattice parameters were calculated. The exchange varies slowly with the crystal volume. The theoretical calculation of exchange anisotropy with a free-electron model is not inexact a priori. The derivatives of exchange energy were also calculated with the assumption of isotropic exchange: then, it was found that the two components of exchange have different variations with the lattice parameters, and this fact confirms that exchange is anisotropic. (auth)

52948 (IS-T-464) MAGNETOELASTIC EFFECTS IN TERBIUM AND DYSPROSIUM. **Vigren, Dennis Thomas (Ames Lab., Iowa). Aug 1971. Contract W-7405-eng-82. 75p. Dep. NTIS.**

Thesis.

A detailed theoretical study was made of the magneto-elastic perturbation of the spectra of elementary spin and lattice excitations in Tb and Dy metals. The theory was formulated on the basis of an interaction formed from bilinear products of local spin and strain functions. Previous ad hoc models appear in certain limits of the theory, giving a coherence to the theoretical picture of magneto-elastic coupling. It is found that uniform magnetostriction causes a smooth transition from "free lattice" to "frozen lattice" perturbation of the magnon spectrum depending on the wave vector of the state. The microwave absorption versus magnetic field applied along the hard planar axis of Tb and Dy is calculated. It is found that free-lattice magnons are primarily responsible for low-frequency absorption in Tb below 140°K, and for both low- and high-frequency absorption in Dy below the Curie temperature of that metal. It is shown that the transition from free- to frozen-lattice behavior of the magnon spectrum is essential to the explanation of existing data on the temperature dependence of absorption peak positions in Tb. The dynamic interaction between spin and lattice waves is derived and used to calculate the mixed-mode splittings in regions of the Brillioun zone of Tb where phonon and magnon dispersion curves cross. The theory predicts well the splitting that occurs where the acoustical magnon and phonon branches touch, but fails to account for the splitting between the acoustical magnon and optical phonon branches. (auth)

52949 (IS-T-471) MICROWAVE ABSORPTION IN TERBIUM, ERBIUM, AND $MnAu_2$ AT SELECTED FREQUENCIES FROM 20 TO 120 GHz. **Hart, Lynn Winterton (Ames Lab., Iowa). Sep 1971. Contract W-7405-eng-82. 151p. Dep. NTIS.**

Thesis.

Ferromagnetic resonance at 24 GHz was used to experimentally confirm free-lattice-model behavior in Tb at low microwave frequencies as predicted by Vigren and Liu. The resonances for $T < 140°K$ were only observable when H_{dc} was not precisely aligned along an a-axis in the hexagonal plane of the sample. $MnAu_2$ has planar spiral magnetic ordering below a Néel temperature of 363°K. Microwave absorption studies of polycrystalline $MnAu_2$ were used to observe perhaps five distinct magnetic resonances. Microwave absorption studies of Er single crystals were made at 24 and 100 GHz. No spin wave resonance absorption was observed with a magnetic field along the $\langle 0001\rangle$, $\langle 10\bar{1}0\rangle$, or $\langle 11\bar{2}0\rangle$ directions in Er at either of our two experimental frequencies, in accord with theory. Several previously reported magnetic transitions along these directions were observed, however. (D.L.C.)

52950 EFFECT OF HYDROSTATIC PRESSURE ON SELF-DIFFUSION IN SINGLE CRYSTALS OF INDIUM. **Ott, Aadu; Norden-Ott, Aslaug (Univ. of Arizona, Tucson). J. Appl. Phys.; 42: No. 10, 3745-9(Sep 1971).**

The pressure effect on the self-diffusion rate in single crystals of indium metal was measured parallel and perpendicular to the tetragonal axis using a radioactive tracer deposition and sectioning method. The experiments were performed at three different temperatures (118, 132, and 148°C) and at hydrostatic pressures varying from 1.2 to 9.6 kbar. The diffusion rate was observed to decrease with increasing pressure; the activation volume for the diffusion process was determined to be 8.1 ± 0.4 cm^3 mole, with no detectable dependence on temperature or crystallographic orientation. Comparison with theoretical relations suggests the vacancy mechanism for diffusion. (auth)

52951 RESISTIVITY MINIMA IN Y-STABILIZED β-Ce ALLOYS. IMPURITY EFFECTS. Hill, H. H.; Elliott, R. O. (Los Alamos Scientific Lab., N. Mex.). Phys. Status Solidi (a); 6: No. 1, 273-80(16 Jul 1971).

Minima in the resistivity-temperature curves for the dhcp alloy Ce-16 at. % Y were induced by the addition of 5 or 10 at. % of Sc, Lu, or Pu. The minima presumably result from an enhancement of the Kondo-type scattering thought to exist in Y-stabilized β-Ce alloys but which at the 16 at. % Y concentration, in the binary alloys, is apparently not strong enough to produce a resistivity minimum. The enhancement of the scattering caused by the addition of impurities is interpreted as being due to: (1) a decrease in the overall Ce concentration in the alloy, and (2) an impurity-induced increase in the effective internal pressure on the Ce atoms in the alloy. (auth)

52952 INVESTIGATION OF SWITCHING PHENOMENA IN $Nb-Nb_2O_5$-METAL DIODES. **Luginbuhl, Heinz Walter. Lafayette, Ind.; Purdue Univ. (1971). 159p. University Microfilms Order No. 71-20,498.**

Thesis.

The switching behavior of Nb/Nb_2O_5/metal diodes was studied. The current-voltage characteristics of the devices were measured during microscopic observation of the device surface. The surface potential was displayed using a scanning electron microscope during the electrical measurements. The results obtained indicated nonhomogeneous conduction through the oxide in certain conduction states. (TSS) (Diss. Abstr. Int., B)

52953 ANOMALOUS SPECIFIC HEAT OF NIOBIUM AT 3°K. **Moore, M. A.; Paul, D. I. (Oxford Univ.). Solid State Commun.; 9: No. 15, 1303-5(1 Aug 1971).**

Niobium and niobium-tungsten alloys have a sharp change in the slope of the specific heat curves (C/T vs T^2) in the normal state near 3°K. This anomalous behavior is explained and the curves reproduced to within the experimental accuracy by considering the effects resulting from a Kohn anomaly in the phonon density of states at low energies. (auth) (UK)

52954 ARGON PLASMA SYNTHESIS AND ELECTRIC AND MAGNETIC STUDIES OF SUBSTOICHIOMETRIC SCANDIUM OXIDE. **Young, John Edward Jr. Ithaca, N. Y.; Cornell Univ. (1971). 100p. University Microfilms Order No. 71-18,930.**

Thesis.

Procedures are described for preparation of clear crystals of substoichiometric Sc_2O_3, using an oxy-hydrogen flame fusion torch, as well as crystals of substoichiometric Sc_2O_{3-x}, utilizing a high-frequency-induction plasma flame fusion torch. If the crystals are grown in a 20% oxygen-80% argon plasma, nearly clear crystals are obtained with stoichiometric composition. If the crystalline boule is grown in a pure argon plasma, black crystals are obtained, the oxygen analysis of which shows a value of x varying from zero to 0.11. On the surface of the boule and in the interior grain boundaries is deposited a metallic film. The oxygen content of the film is lower than that of the crystals, but it was impossible to separate completely the film from the crystals. If the boule is grown in an argon plasma doped with up to 5% hydrogen, the same black crystals are obtained, but the grain boundaries contain much more of the metallic inclusions. Single-crystal rotation photographs and Guinier-type powder patterns show that the black crystals have the same structure as stoichiometric Sc_2O_3 but slightly reduced lattice constants. Single-crystal electrical conductivity measurements were made by the van der Pauw method. The resistivity of the crystals is greater than the 10^{12} ohm input impedance of the measuring instruments. Measurements of the Hall effect and Seebeck coefficient could not be made because of the high resistivity of the material. The magnetic susceptibility was measured by the Faraday method from 1.6° to 300°K. The apparatus constructed for these measurements is described in detail. The substoichio-

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metric materials possess a very small, nearly temperature-independent magnetic moment. Because of the very small measured magnetic moment and the relatively high concentration of defects, it was concluded that more than one defect species must be present. These would most likely be the Sc^{1+} ion in the ^3D state, with a magnetic moment of 2.83 μ_B in equilibrium with the Sc^{1+} ion in a ^1D or ^1S state, with zero magnetic moment. (Diss. Abstr. Int., B)

52955 CRYSTAL FIELD EFFECTS IN RARE EARTH HEXABORIDES. **Nickerson III, John Charles. Stanford, Calif.; Stanford Univ. (1971). 235p. University Microfilms Order No. 71-19,736.**

Thesis.

Models are presented for the band structure, crystal field sources, exchange integrals, and lattice strain energies in the rare-earth hexaborides. These models explain the observed crystal-field splittings, the magnetic anomalies, transport data, and the observed variations in lattice parameters. The models and their implications display a systematic character which one might expect in a rare-earth (RE) series of compounds. (TSS) (Diss. Abstr. Int., B)

52956 EFFECT OF SUBSTRATE BIAS ON TANTALUM FILMS SPUTTERED IN AN OXYGEN–ARGON MIXTURE. **Westwood, W. D.; Wilcox, P. S. (Bell Northern Research, Ottawa). J. Appl. Phys.; 42: No. 10, 4055-62(Sep 1971).**

Tantalum films were deposited on biased glass and ceramic substrates by dc sputtering in an oxygen–argon mixture. The resistivity of the films was approximately 800 $\mu\Omega$ cm when the substrate bias was zero, but decreased when either positive or negative potential was applied to the substrate. Resistivities of approximately 200 $\mu\Omega$ cm were obtained by applying +100 and –100 V, and resistivities as low as 50 $\mu\Omega$ cm were obtained at a substrate bias of –200 V. The oxygen content of the films, measured by an anodization technique, was approximately 35 at. % on unbiased substrates but decreased with substrate bias. While films deposited at –100 V bias contained approximately 10 at. % oxygen, only half of this amount was present in those deposited at +100 V. The reduction in oxygen content, and thus in resistivity, can be explained by a combination of two effects. For positive and low negative bias, increased gettering due to enhanced sputtering rate is most important, but for higher negative bias, removal of oxygen by argon-ion sputtering is also important. (auth)

52957 ADSORPTION AND GROWTH OF CADMIUM ON POLYCRYSTALLINE TUNGSTEN. **Wagner, R. S.; Voorhoeve, R. J. H. (Bell Telephone Labs., Murray Hill, N. J.). J. Appl. Phys.; 42: No. 10, 3948-59(Sep 1971).**

The multilayer adsorption and growth of cadmium on clean polycrystalline tungsten ribbons (with strong preferred orientation) were investigated with a molecular-beam and mass-spectrometric technique. The adsorption and desorption kinetics were studied as a function of temperature, supersaturation, and coverage. Five distinct adsorption states were found between 100 and 600°C. Growth of bulk cadmium occurs only after multilayer adsorption is complete. No measurable supersaturation or critical nucleation event is observed for the growth of cadmium. However, even at high supersaturation and heavy coverage, the condensation coefficient is still smaller than unity. The kinetic and structural data are explained by the evolution of faceted, crystallographic, and epitaxial cadmium islands on the cadmium multilayer adsorbate. (auth)

52958 ELECTRONIC AND MAGNON SPECIFIC HEAT OF IRON-BASED TUNGSTEN ALLOYS. **Marklund, K.; Hoel, L.; Spahr, K.; Lindqvist, T. (Univ. of Uppsala). J. Low Temp. Phys.; 5: No. 2, 227-36(Aug 1971).**

Specific heat measurements between 0.5 and 2.4°K were carried out on pure Fe and five alloys with W (0.5, 1, 2, 5, and 10 at. % W). The electronic specific heat coefficient γ decreases linearly up to 5%W. For the 10% alloy the coefficient increased almost by a factor of two and a small term, constant in temperature, had to be included in the analysis of the data. A split-band model is believed to explain the decrease as well as the increase of γ. The existence of a magnon contribution to the specific heat was established in all the samples. (auth)

52959 MAGNETIC PROPERTIES OF $(Zr_{1-x}Ti_x)Zn_2$ AND $(Zr_{1-x}Hf_x)Zn_2$ ALLOYS. Kato, Tomohiko; Shimizu, Masao (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 31: No. 3, 723-9 (Sep 1971).

Magnetic properties of $ZrZn_2$ alloys with Ti and Hf are investigated by making use of the Wolff–Clogston model extended to the case of many impurities in the self-consistent Hartree–Fock approximation. The self-consistent equations for Green's function in the magnetic case are derived by using the result obtained by the graphic method for a disordered system. They are solved explicitly in lower concentrations up to the second-order terms with respect to the impurity potential and the difference between intra-atomic Coulomb integrals at an impurity and a host site. By the solution corresponding to the Stoner model for a virtual crystal, the experimental results of the spontaneous magnetization, Curie temperature and spin susceptibilities of $(Zr_{1-x}Ti_x)Zn_2$ and $(Zr_{1-x}Hf_x)Zn_2$ alloys are explained satisfactorily. The correction to the solution for a virtual crystal is estimated to be small. It is concluded that the difference between magnetic properties of these alloys can be explained by the change of the intra-atomic Coulomb integrals in Zr and Ti or Hf atoms. (auth)

52960 MAGNETIC–NONMAGNETIC TRANSITIONS IN ALLOYS WITH CERIUM IMPURITIES. **Coqblin, B. (Faculte des Sciences, Orsay, France); Maple, M. B.; Toulouse, G. Int. J. Magn.; 1: No. 4, 333-40(Aug 1971).**

The continuous transition of dilute metallic alloys from magnetic to nonmagnetic behavior was recently observed experimentally in alloys containing cerium impurities. A brief review of these experiments, which include measurements of the resistivity and of the depression of the superconducting temperature under applied pressure, is presented in connection with the predictions of a phenomenological model. The parameters needed to fit the existing data are consistent with those obtained in pure Ce or in other Ce alloys. (auth) (UK)

52961 E.M.F. PRODUCED IN COMPRESSION OF LANTHANIDES. **Mineev, V. N.; Ivanov, A. G.; Lisitsyn, Yu. V.; Novitskii, E. Z.; Tyunyaev, Yu. N. Zh. Eksp. Teor. Fiz.; 61: No. 1, 254-61(Jul 1971). (In Russian).**

An emf was observed on shock compression of cerium, europium, and ytterbium samples and was investigated. Possible sources of the emf are considered: (a) shock polarization, (b) diffusion of charged carriers from the shock wave front, (c) inertial forward motion of charge carriers, and (d) thermal emf. Some proofs are presented that the emf observed in some cases is due to mechanisms (a) or (b). (auth)

52962 OPTICAL PROPERTIES OF MOLYBDENUM SINGLE CRYSTALS. **Kirillova, M. M.; Nomerovannaya, L. V.; Noskov, M. M. (Inst. of Physics of Metals, Sverdlovsk, USSR). Zh. Eksp. Teor. Fiz.; 60: No. 6, 2252-9(Jun 1971). (In Russian).**

The refractive index n and absorption coefficient k are measured in the 0.265- to 20-micron (4.9 to 0.06 eV) spectral range for Mo(100). The conduction electron plasma frequency Ω is determined by infrared measurements and is compared with estimates obtained in the gas approximation. Interband electron transitions in molybdenum are studied in detail. An additional absorption band in the vicinity of 0.5 to 1.0 eV which previously had not been observed is detected on the high-frequency conductivity curve $\sigma(\omega)$. The results are discussed on basis of available data concerning the energy spectrum of molybdenum. (auth)

52963 ELECTRICAL RESISTANCE OF LANTHANUM AND CERIUM. **Pavlov, V. S.; Pankrat'eva, M. I. (Kharkov State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 107-9(1970). (In Russian).**

Electrical resistances of La and Ce were studied as functions of the temperature and impurity content. At 25°C, the electric resistance for non-purified La was 68.55 μohm · cm and for purified La 49 μohm · cm. A sharp jump in electrical resistance was observed at 310°C which was related to the $\beta \rightarrow \alpha$ phase transition. For non-purified cerium, the electrical resistance at 25°C was 75.74 μohm · cm, and after purifying was 67.50 μohm · cm. (R.V.J.)

52964 MAGNETORESISTANCE AND HALL EFFECT OF METAL CARBIDES OF IVA SUBGROUP. **Malinskii, B. I.; Nemchenko, V. F.; L'vov, S. N. (Kherson State Teacher's Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 125-9(1970). (In Russian).**

The magnetoresistance and Hall effect of TiC, ZrC, and HfC were studied as functions of magnetic field intensity at room temperature and 78°K. Measurements were made in a magnetic field varying from 5 to 25 kOe. (R.V.J.)

52965 ELECTRIC RESISTIVITY OF SOLID SOLUTIONS IN Pu–Ga ALLOYS IN THE ∂ PHASE AT VERY LOW TEMPERATURES (4.2 TO 300°K). Joel, J.; Roux, C.; Rapin, M. (CEN de Bruyere-le-Chatel, Montrouge, France). J. Nucl. Mater.; 40: No. 3, 297-304(Sep 1971). (In French).

The variations of electric resistivity as a function of temperature of eight delta-phase Pu–Ga alloys were studied between 5 and 300°K. After a succinct description of the experimental device and of the characteristics of the samples, the results are expressed as $\rho = f(T)$ curves for each concentration and $\rho = f$ (concentration) curves at different temperatures. For unalloyed α-plutonium, the resistivity of each ∂-phase Pu−Ga alloy displays a maximum and, for Pu−Al and Pu−Ce alloys, this maximum is closely related to the concentration. From 3 to 10 at. %, Pu−Ga alloys do not undergo any phase transformation when they are cooled to 5°K. On the other hand, those with a low concentration (1 and 1.7 at. %) transform partially to α phase below 300°K. The α phase obtained is kept under a metastable state at 300°K. (auth)

52966 EMISSIVITY OF MONOCARBIDES OF TITANIUM AND NIOBIUM AND THEIR ALLOYS IN THE REGION OF HOMOGENEITY. Okhemchuk, L. N.; Podchernyaeva, I. A.; Upadkhaya, G. Sh.; Fomenko, V. S. (Kiev Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 11, 126-7(1969). (In Russian).

The temperature dependence of the monochromatic coefficient of emissivity, E_λ, (for λ = 655 mμ) was investigated experimentally for the monocarbides of titanium and niobium, and also from their alloys in the region of homogeneity. The measurements were conducted on compact forms in the range of temperatures 1200 to 2100°K, utilizing a model of an absolutely black body, according to the methods of Fomenko et al. (Ogneupory, No. 1, 40(1962)), with an accuracy of 15 to 20%. (tr-auth)

52967 ADVANCES IN MATERIALS RESEARCH. VOLUME 5. Herman, Herbert (ed.). New York; John Wiley and Sons, Inc. (1971). 506p. $32.50.

The seven articles review respectively: internal oxidation in alloys, eutectic grains, effects of plastic deformation on magnetic properties of metals and alloys, crystal interface models, growth of single crystals, fracture and strength of polymers, and computer techniques used in dislocation analyses. A subject index, and a cumulative index for volumes 1 through 5, are included. (D.L.C.)

52968 MAGNETIC SUSCEPTIBILITY OF VANADIUM CARBIDE. Bloom, D. W. (Univ. of Colorado, Boulder); Finegold, L.; Tveten, A.; Lye, R. G. Phil. Mag.; 24: No. 189, 603-12(Sep 1971).

The magnetic susceptibility of single-crystal VC_x (x = 0.76, 0.81, 0.84, 0.87) was found to decrease sharply as x increases from 0.76, in qualitative agreement with the results of previous measurements made by Bittner and Goretzki (1962) on powder specimens. The present results, however, show a minimum near x = 0.84 followed by a slight increase at x = 0.87, and in this respect are similar to the observations of Borukhovich and his collaborators (1969) in their studies of the other Group V carbides NbC_x and TaC_x. This variation of the susceptibility is attributed primarily to the (Van Vleck) orbital paramagnetism, supporting the suggestion made previously by Froidevaux and Rossier (1967). A simple model for the orbital paramagnetism in VC_x is shown to account qualitatively for the observed variation with carbon content. (auth) (UK)

52969 PRELIMINARY EXPERIENCE WITH ION-BEAM THINNING OF SEMICONDUCTOR MATERIALS. Lidbury, D. P. G.; Pettit, H. R.; Booker, G. R. (Oxford Univ.). Electron. Eng.; 43: No. 523, 50-3(Sep 1971).

Semiconductor specimens were thinned for transmission-electron microscopy using both the jet-chemical and ion-beam methods, and the two methods are shown to be complementary. The ion-beam method is particularly suitable for specimens containing p−n junctions, impurity segregation, etc., and for preparing special-geometry specimens, e.g., sections through epitaxial layers grown on underlying substrates. (auth) (UK)

Moessbauer Effects and NMR

52970 (A/CONF.49/P–688) SOME APPLICATIONS OF MOESSBAUER EFFECT IN SCIENCE AND ENGINEERING. Goldanskii, V. I.; Dolenko, A. V.; Egiazarov, B. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, [Moscow]). Jun 1971. 28p. (CONF-710901-361). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Two branches of the Moessbauer effect applications in the Soviet Union are reviewed: gamma resonance spectroscopy of high molecular compounds and development and industrial use of analytical methods and instruments. (M.O.W.)

52971 (CONF-711001-(Vol.1), pp 144-51) MOESSBAUER SPECTROSCOPY IN THE RARE EARTHS. Cohen, R. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). 1971.

From ninth rare earth research conference; Blacksburg, Va. (10 Oct 1971).

A brief survey is presented of Moessbauer spectroscopy and its possibilities for research on rare-earth materials. An introduction to the isomer shift and hyperfine structure (hfs) is given, and some of the areas of information that can be obtained from hfs measurements are outlined. Slow relaxation effects are considered. A table of rare earth elements with predicted degree of ease for Moessbauer research and current status of research is presented. It is pointed out that the hyperfine splitting is almost always <100 times the observed resonance linewidth. (D.L.C.)

52972 (IS-T–479) STUDY OF CRYSTALLINE ELECTRIC FIELDS IN SOME THULIUM ALUMINUM COMPOUNDS. Pinter, Thomas Gerald (Ames Lab., Iowa). Sep 1971. Contract W-7405-eng-82. 126p. Dep. NTIS.

Thesis.

The crystal field in Tm_3Al_2 was investigated by measuring the temperature dependence of the nuclear quadrupole-splitting of the 8.42-keV gamma transition in ^{169}Tm and by NMR measurements of the quadrupole coupling parameter of ^{27}Al. The Moessbauer effect study was carried out between 77 and 300°K. The observed asymmetric lineshape was fit to a theoretical relaxation lineshape by computer using several variable parameters. Crystal-field parameters for the $m-C_s$ point symmetry in Tm_3Al_2 were determined by a best fit to the temperature dependence of the quadrupole interaction. Overall crystal-field splittings were found to be roughly 300 cm^{-1} for two of the three inequivalent thulium sites. Values for the crystal-field shielding parameters and for the conduction electron contributions to the electric-field-gradient tensor were derived from the data. The asymmetry observed in the Moessbauer line shape was attributed to an indirect s−f exchange interaction between thulium ions in the paramagnetic state. In addition, the polarization of the conduction electrons brought about by this interaction causes a negative Knight shift of the ^{27}Al NMR spectrum. The s−f exchange parameters for the two thulium sites were approximately −0.25 eV and +0.45 eV, as inferred from the measured temperature dependence of the ^{27}Al Knight shift in the range 180 to 400°K. The significance of the positive exchange parameter is not understood. (auth)

52973 THEORY OF γ-QUANTA TRANSMISSION THROUGH A RESONANT MEDIUM. Fam Zui Hien (Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 1, 359-66(Jul 1971). (In Russian).

The refractive index of a resonant medium is studied by taking into account coherent multiple scattering of γ quanta by nuclei located in the lattice. A general formula is derived for the refractive index of Moessbauer γ quanta in polycrystals. In the short-wavelength range ($\lambda \ll a$, where λ is the γ quantum wavelength and a is the interatomic distance), coherent multiple γ quantum scattering in a polycrystal yields a contribution proportional to $(\lambda/a)^2$. The time dependence of the probability of passage of γ quanta through a resonant filter is calculated. Characteristics of Moessbauer spectra that depend on the delay time are considered, and the spectra are compared with the ordinary Moessbauer spectra. (auth)

52974 ANOMALOUS TEMPERATURE DEPENDENCE OF THE QUADRUPOLE INTERACTION IN CADMIUM. Raghavan, R. S.; Raghavan, P. (Technische Univ., Garching, Ger.). Phys. Lett.; 36A: No. 4, 313-14(13 Sep 1971).

The quadrupole interaction of the 247-keV level of ^{111}Cd in Cd metal, measured at several temperatures up to T = 575°K by differential perturbed angular correlations, shows a rapid decrease with T in contrast to a relative increase expected from the anisotropic expansion of the Cd lattice. (auth)

52975 ELECTRON SPIN RESONANCE IN LIQUID LITHIUM. Taupin, C.; Lambert, M.; Mazieres, Ch. (CNRS, Orsay, France). J. Phys. Chem. Solids; 32: No. 9, 2045-52(Sep 1971). (In French).

Relaxation time measurements were made on samples of n-irradiated lithium fluoride, which contained very pure particles of lithium metal. Thermal variation of the ESR linewidth exhibited a broadening of 0.2 G at the melting point. In the liquid state, linewidth increased very rapidly with temperature. These results are different from the results obtained by others on sodium. Several relaxation process are discussed. (auth) (UK)

Theoretical Physics

Refer also to abstracts 53357 and 53391.

52976 CANONICAL TRANSFORMATIONS IN QUANTUM MECHANICS. Schroeter, J.; Westroem, M. (Univ., Marburg, Ger.). Ann. Phys. (Leipzig); 26: No. 1, 59-65(1971).

XUM

The kinematics and dynamics of classical and quantum mechanical systems are discussed. In a mathematical strict way, canonical transformations are introduced and the time development of quantum mechanical systems as well as the Schroedinger and Heisenberg picture are considered. (auth)

52977 TIME-DEPENDENT COORDINATE TRANSFORMATIONS. Schroeter, J.; Westroem, M. (Univ., Marburg, Ger.). Ann. Phys. (Leipzig); 26: No. 1, 66-72(1971).

The general formalism of time-dependent canonical transformations is applied to the case of coordinate transformations in classical and quantum mechanics. (auth)

52978 INVARIANCE PRINCIPLE FOR GENERALIZED WAVE OPERATORS. Matveev, V. B. (Leningrad State Univ.). Teor. Mat. Fiz.; 8: No. 1, 49-54(Jul 1971). (In Russian).

The limits of the form $W_{\pm}(H,H_0|\Lambda) = \underset{t\to\pm\infty}{s\text{-}\lim} \exp\{itH\}\Lambda(t)$ in the Hilbert space are considered within the following assumptions: $\varphi(H)W_{\pm} = W_{\pm}\varphi(H_0)$ for any function φ, the operators H and H_0 are self-adjoint and $\Lambda(t)$ is bounded. The invariance principle states the independence of the choice of f and the coincidence of the limit $\underset{t\to\pm\infty}{s\text{-}\lim} \exp\{if(H,t)\}\, Q(\varphi,t)$ with $W_{\pm}(H,H_0|\Lambda)$ (Q is a certain operator constructed from Λ and f in the explicit form). A certain theorem is proved making it possible to justify the invariance principle in several cases. The applications of this theorem to the Schrödinger equation are considered. (auth)

52979 QUASIPOTENTIAL EQUATION FOR RELATIVISTIC HARMONIC OSCILLATOR. Donkov, A. D.; Kadyshevskii, V. G.; Mateev, M. D.; Mir-Kasimov, R. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 8: No. 1, 61-73 (Jul 1971). (In Russian).

A relativistic generalization of the exactly solvable harmonic oscillator problem is studied in the framework of the quasi-potential approach. Quasi-potential wave functions are constructed in the form of the expansions over wave functions of the corresponding nonrelativistic problem. Relativistic corrections to the energy levels are obtained. (auth)

52980 KERNELS REALIZING ASSOCIATIVE MULTIPLICATIONS BETWEEN PHASE-SPACE FUNCTIONS. Simoni, A. (Univ., Naples); Zaccaria, F.; Sudarshan, E. C. G. Nuovo Cim.; 5B: No. 1, 134-42(11 Sep 1971).

An analysis is shown of integral kernels realizing multiplication between phase-space functions, which are in a correspondence with quantum-mechanical variables of a nonrelativistic system. Kernels satisfying the associative property are found as solution of a functional equation. (auth)

52981 INDUCED RADIATION OF ELECTRON BEAMS IN CYLINDRICAL RESONATORS. Grigor'ev, V. P.; Privezentsev, A. P. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 11, 152-3(1969). (In Russian).

In an earlier work (IVUZ, Fizika, No. 5, 154(1968)) there was considered, in the single-particle approximation, the emission induced by electrons moving along the periphery of a cylindrical resonator placed in a constant uniform magnetic field excited by an external generator. This emission is examined here by means of the kinetic equation for azimuthal uniform beams. (tr-auth)

52982 LINEAR CANONICAL TRANSFORMATIONS AND THEIR UNITARY REPRESENTATIONS. Moshinsky, M.; Quesne, C. (Univ. of Mexico, Mexico City). J. Math. Phys. (N. Y.); 12: No. 8, 1772-80(Aug 1971).

It is shown that the group of linear canonical transformations in a 2N-dimensional phase space is the real symplectic group Sp(2N) and its unitary representation in quantum mechanics when the N coordinates are diagonal is discussed. It is shown that this Sp(2N) group is the well-known dynamical group of the N-dimensional harmonic oscillator. Finally, the case of n particles in a q-dimensional oscillator potential, for which N = nq is studied, and the chain of groups $Sp(2nq) \supset Sp(2n) \times O(q)$ is discussed. (auth)

52983 CANONICAL TRANSFORMATIONS AND MATRIX ELEMENTS. Quesne, C.; Moshinsky, M. (Univ. of Mexico, Mexico City). J. Math. Phys. (N. Y.); 12: No. 8, 1780-3 (Aug 1971).

The ideas on linear canonical transformations developed previously are used to calculate the matrix elements of the multipole operators between single-particle states in a three-dimensional oscillator potential. First, the oscillator states in the chain of groups $Sp(6) \supset Sp(2) \times O(3)$, $Sp(2) \supset O_S(2)$, and $O(3) \supset O_L(2)$ are characterized, and then the multipole operators are expanded in terms of irreducible tensors with respect to the $Sp(2) \times O(3)$ group. Their matrix elements are obtained by applying the Wigner–Eckart theorem with respect to both the Sp(2) and O(3) groups. In this way an explicit expression for the radial integral of r^k, $k > 0$, is obtained. (auth)

52984 DERIVATION OF THE GENERALIZED KINETIC EQUATION FOR THE SINGLE-PARTICLE DISTRIBUTION FUNCTION. Zubarev, D. N.; Novikov, M. Yu. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 36A: No. 4, 343-4(13 Sep 1971).

The non-Markoffian kinetic equation for the single-particle distribution function of a classical system is derived by means of introducing in the Liouville equation the infinitesimal sources. The known kinetic equations follow from this equation in the Markoffian approach. (auth)

52985 CONDENSATION IN THE HARD-SPHERE BOSE GAS. Hara, Hiroaki; Ichimura, Hiroshi (Tohoku Univ., Sendai. Tokyo Inst. of Tech.). Progr. Theor. Phys. (Kyoto); 45: No. 6, 2002-3(Jun 1971).

In previous papers (Prog. Theor. Phys., 39: 907(1968) and Prog. Theor. Phys. Suppl. No. 44, 118(1969)), the behavior of one- and two-particle reduced density matrices for the degenerate quantum system was investigated. Here, results are presented of detailed calculation based on the formulas obtained by a reformulation of methods proposed in the above papers. (auth)

52986 MATHEMATICS OF THE MEASUREMENT PROBLEM IN QUANTUM MECHANICS. Tutsch, J. H. (Univ. of Wisconsin, Wausau). J. Math. Phys. (N. Y.); 12: No. 8, 1711-18(Aug 1971).

The mathematical structure of the simplest nontrivial hidden variable theory is derived. The core of the resulting theory is an essentially unique nonlinear differential equation, which gives a causal description of the continuous collapse of the wave function during a measurement. It is shown that the simplest collapse equation is the same as the equation given ad hoc by Bohm and Bub. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 53038, 53046, 53047, 53403, 53422, and 53748.

52987 (LA-4637) PROCEEDINGS OF LAMPF THEORETICAL STUDY GROUP, JANUARY 25–29, 1971. (Los Alamos Scientific Lab., N. Mex.). Feb 1971. Contract W-7405-eng-36. 14p. (CONF-710112). Dep. NTIS.

A theoretical study group met for the purpose of seeing what LAMPF can do to help solve the problems of nuclear and particle physics. Among things considered and discussed were what experiments should be done, what is needed for their interpretation, and what their impact on present understanding will be. (R.W.R.)

52988 (NP-18909) ANNUAL REPORT, 1970. (Daresbury Nuclear Physics Lab. (England)). 135p. Dep. NTIS (U. S. Sales Only).

Details are given of work in experimental physics and theoretical physics, work at the synchrotron radiation facility, in computing and electronics at the electron synchrotron (operation and development), in machine physics, in engineering, in health and safety, administration, and publications by staff. It is stated that 1970 was a very productive year for the NINA experimental programme. Work was also started on the Synchrotron Radiation Facility, which is intended to exploit synchrotron radiation in the range 1 to 2000Å, produced copiously in NINA. (UK)

52989 (PITHA-48) SEARCH FOR PARTICLES WITH PARTIAL CHARGE IN SHOWERS. Boehm, A.; Diemont, W.; Faissner, H.; Fasold, H. G.; Krisor, K.; Maull, K.; Sawaf, Z.; Umbach, H. (Technische Hochschule, Aachen (West Germany). Physikalisches Institut (III)). Mar 1971. 15p. (In German). Dep. NTIS (U. S. Sales Only).

Cosmic ray showers were analyzed with a proportional-counter-hodoscope. During a measuring time of 327 hours, 78,600 showers were observed. These were studied for tracks of quarks with a charge of one-third of two electrons. For three energy ranges from 10^{13} to 10^{16} eV, the number of quarks/shower were as follows: 0.14, 0.19, and 44. The experiments seemed to indicate that quarks occur only in showers in excess of 10^{15} eV. (H.B.G.)

Electromagnetic

Refer also to abstracts 53088 and 53296.

52990 (DESY-71/28) EXPERIMENTS ON THE $e^{\pm}e^{-}$ STORAGE RING. Schildknecht, D.; Willutzki, H. J.; Wolf, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1971. 72p. (In German). Dep. NTIS (U. S. Sales Only).

Both theoretically and experimentally the e^+e^- storage ring is studied. The analysis comprises tests of quantum electrodynamics; pair formation and bremsstrahlung on nuclei; and QED experiments on storage rings. Subsequently treated is hadron production single photon exchange, baryon—antibaryon production, meson production, multiple particle processes, total cross sections, and the measurement of a single hadron in its end condition. Also discussed are hadron production through electron exchange, $\gamma\gamma$-processes, selection rules for $\gamma\gamma$ scattering, and experiments involving weak interactions. (H.B.G.)

52991 (DESY-71/37) PRECISE DETERMINATION OF ρ,ω INTERFERENCE PARAMETERS FROM PHOTOPRODUCTION OF VECTOR MESONS OFF NUCLEON AND NUCLEI. Alvensleben, H.; Becker, U.; Busza, W.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jul 1971. 11p. Dep. NTIS (U. S. Sales Only).

The ρ,ω interference in dipion photoproduction was studied in the energy range 5 to 7 GeV with a total of 630,000 pion pairs from hydrogen, carbon, and lead. The mass spectra show clear interference in the vicinity of the omega mass. The interference parameters $\xi = 0.0106 \pm 0.0012$, $\alpha = (96 \pm 15)^\circ$ and $\Gamma_{\omega\to 2\pi}/\Gamma_{\omega\to \mathrm{all}} = (1.22 \pm 0.30)\%$ are obtained where the errors include model dependent uncertainties and are twice the size of the statistical errors alone. (auth)

52992 (LAL-RI-71-3) STUDY OF THE BACKWARD PHOTOPRODUCTION REACTION $\gamma + p \to K^+ + \Lambda^0$ AT ENERGIES BETWEEN 1 AND 2 GeV. Decamp, D. (Paris Univ., Orsay (France). Faculte des Sciences). Apr 1971. 65p. (In French). Dep. NTIS (U. S. Sales Only). Thesis.

The Orsay linear accelerator was used to study the backward photoproduction of strange particles at energies between 1 and 2 GeV. Differential cross sections were obtained for the $\gamma + p \to K^+ + \Lambda^0$ reaction with an accuracy between 3 and 5%. The use of a high discrimination (decelerator, Cherenkov, high thresholds) and, in particular, time of flight techniques, allowed the K to be detected in spite of the considerable background noise due to parasitic particles (number of parasite events/number of K events $\simeq 10$). The measurements revealed structures distributed about the total energies in the center of mass system at 1700 and 1900 MeV. Isobars contribute negligibly to the cross sections. Systematic measurements, particularly of the Λ^0 polarization would have allowed the nature of the isobars contributing to the structure to be more precisely determined. On the other hand, the fact the Born terms have a large contribution to the cross section confirms that these measurements are a good test of the $g_{K\Lambda N}$ coupling constant. The value derived from the best fit of the results obtained is $g_{K\Lambda N} \simeq 8.5$. This value is distinctly lower than that predicted by SU_3 ($g^2_{K\Lambda N}/4\pi = 16$). The majority of recent analyses, however, either on photoproduction, or strong interactions lead to values for $g_{K\Lambda N}$ lying between 5 and 10, which are in good agreement with the result obtained. (France)

52993 EXPERIMENTAL STUDY OF THE PION ELECTROPRODUCTION MECHANISM ON COMPLEX NUCLEI. Titov, Yu. I.; Stepula, E. V.; Afanas'ev, N. G.; (and others) (Physical-Technical Inst., Kazan). Yadern. Fiz.; 13: No. 6, 1149-56(Jun 1971). (In Russian).

Results of investigation of 1000 to 1178 MeV electron scattering on C, Al, Ni, Mo, W within 20 to 60° scattering angles are given. The data are analyzed in the impulse approximation using the Fermi nucleon momentum distribution. At the 4-momentum transfer squared more than $9F^{-2}$ the impulse approximation describes satisfactorily the data both for the electron quasielastic scattering and for the pion electroproduction. (auth)

52994 CROSS SECTION OF ELECTRON–POSITRON PAIR PRODUCTION INDUCED BY γ QUANTA WITH ENERGIES FROM 35 UP TO 2000 MeV IN LIQUID XENON. Dvorakovskii, M.; Slovinskii, B.; Strugal'skii, Z.; Yanovskaya, B. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 6, 1262-4(Jun 1971). (In Russian).

Cross sections of electron—positron pair production by γ quanta with energies from 35 up to 2000 MeV in liquid Xe are determined. The work is fulfilled with photographs exposed on the Xe bubble chamber. The cross sections obtained in the experiment are compared with the results of calculations. Such a comparison is of interest in view of testing the validity of approximations applied in the calculations. The results may be useful also in some applied problems dealing with the penetration of the γ rays through matter. In particular, they are suitable in solving methodical problems arising in experiments with heavy liquid bubble chambers. (auth)

52995 INELASTIC ELECTROMAGNETIC NUCLEON FORM FACTORS. Nauenberg, Michael (Univ. of California, Santa Cruz). pp II25-35 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

The recent very high energy inelastic electron-proton scattering experiments carried out at SLAC and DESY are reviewed and a phenomenological method to analyze the data is discussed. Some recent theoretical speculations about the asymptotic behavior of the inelastic electromagnetic nucleon form factors are presented and confronted with the analyses of the data. (France)

52996 STATUS REPORT OF THE EXPERIMENTS ON THE FLOOR AT ADONE: THE FRASCATI e^+e^- STORAGE RING. Silvestrini, V. (Comitato Nazionale per l'Energia Nucleare, Frascati, Italy). pp II66-73 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

Head-on collisions occur in the four experimental sections of Adone simultaneously, allowing four experiments to run at the same time. Seven apparatus have been prepared for experiments: (1) $e^+e^- \to$ photons, (2) $e^+e^- \to \mu^+\mu^-$, (3) $e^+e^- \to$ vector bosons, (4) $e^+e^- \to \phi \to K^+K^-$, (5) $e^+e^- \to 2\pi$ or 2k, (6)

XUM

$e^+e^- \rightarrow \bar{p}p$, (7) $e^+e^- \rightarrow$ leptonic quarks. The ϕ and $\bar{p}p$ experiments cannot be performed at present. The apparatus for the "$e^+e^- \rightarrow \mu\mu(\pi\pi)$" and "the vector boson search" experiments are presented with preliminary information on the analysis of the data. (France)

52997 VECTOR MESON PHOTOPRODUCTION. Braccini, P. L. (Istituto Nazionale di Fisica Nucleare, Pisa, Italy). pp II94-110 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

The production of vector mesons by high-energy beams of monochromatic photons and of polarized photons is discussed. The ρ^0 and ϕ photoproduction on hydrogen and deuterium confirm predictions of the vector dominance relation combined with the quark model. It is concluded that ρ^0 and ϕ photoproduction proceed mainly via diffraction, whereas a large nondiffractive contribution must be effective in ω photoproduction. Attempts to determine independently the total vector-meson-proton cross sections by measuring the dependence on A of the differential cross sections on complex nuclei (Be, C, Al, Ti, Cu, Ag, Cd, In, Ta, W, Zn, Pb) are also described. (auth)

52998 EXPERIMENTAL TESTS OF THE VECTOR DOMINANCE MODEL IN PSEUDOSCALAR MESON PHOTOPRODUCTION. Dar, A. (Technion-Israel Inst. of Tech., Haifa). pp II111-46 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

The experiment tests of the vector meson dominance model in photoproduction of pseudoscalar mesons are reexamined. The ambiguities associated with the model are discussed. Impressive evidence for the validity of the model is presented, and new possible tests, in particular clean tests, of the model are proposed. (France)

52999 SEARCH FOR $\mu^+ \rightarrow e^+ + e^+ + e^-$ DECAY. Korenchenko, S. M.; Kostin, B. F.; Mitsel'makher, G. V.; Nekrasov, K. G.; Smirnov, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 6, 1265-6(Jun 1971). (In Russian).

Search for $\mu^+ \rightarrow e^+ + e^+ + e^-$ decay was carried out using a magnetic spark spectrometer. It is found that $W(\mu^+ \rightarrow e^+ + e^+ + e^-)/W(\mu^+ \rightarrow e^+ + \nu_e + \bar{\nu}_\mu) \leq 6.2 \cdot 10^{-9}$ with 90% confidence level. (auth)

53000 GENERATION OF ELECTRON–POSITRON PAIRS IN NUCLEAR COULOMB FIELD. Kryshkin, V. I.; Sterligov, A. G.; Usov, Yu. P. (Tomsk Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 6, 101-2(1970). (In Russian).

The angular distribution of electron–positron pairs was studied for a quasi symmetrical distribution of energy between particles of the pair emitted from the target at large angles (exceeding the magnitude value of (m_eC^2/E_e)). The scheme of the experiment using a bremsstrahlung electron beam from the Sirius synchrotron with a maximum energy of 1.1 GeV is given, and graphical data on the angular distribution according to the incidence γ-quanta (900 ± 200 MeV) are included. Data obtained are not in agreement with the data obtained previously for the quasi symmetrical pair distribution. The observed increase of angles was considered the result of the contribution of the pair scattering in the target. Consequently, with the target thickness 0.01 rad length the scattering in the target plays a determining role in the angular distribution of electron–positron pairs. (R.V.J.)

53001 RELATION BETWEEN ENERGY AND MOMENTUM FOR ELECTRONS OF A FEW MeV. Stovall, T. (Ecole Normale Superieure, Orsay, France); Trail, C.; Philippot, J. C. Nuovo Cim.; 5B: No. 1, 79-82(11 Sep 1971).

The energies of electrons scattered in head-on collisions by photons with energies of 1 to 3 MeV were measured and found to agree with the predictions of special relativity to an experimental uncertainty of 0.1%. (auth)

53002 PRECISE DETERMINATION OF $\rho-\omega$ INTERFERENCE PARAMETERS FROM PHOTOPRODUCTION OF VECTOR MESONS OFF NUCLEON AND NUCLEI. Alvensleben, H.; Becker, U.; Busza, W.; (and others) (Massachusetts Inst. of Tech., Cambridge. DESY, Hamburg). (Phys. Rev. Lett.; 27: No. 13, 888-92 (27 Sep 1971).

The $\rho-\omega$ interference was studied in di-pion photoproduction in the energy range 5 to 7 GeV with a total of 630,000 pion pairs from hydrogen, carbon, and lead. The mass spectra show clear interference in the vicinity of the ω mass. A branching ratio $\Gamma_{\omega\rightarrow 2\pi}/\Gamma_{\omega\rightarrow \text{all}} = (1.22 \pm 0.30)\%$ and a relative phase to the $\rho \rightarrow \pi\pi$ amplitude of 96° ± 15° is found, where the errors include model-dependent uncertainties and are twice the size of the statistical errors alone. (auth)

53003 REACTION $\pi^-p \rightarrow \gamma\gamma n$ AT 3.65 GeV/c. Harvey, E. H. (Univ. of Minnesota, Minneapolis); Marquit, E.; Peterson, E. A.; (and others). Phys. Rev. Lett.; 27: No. 13, 885-8(27 Sep 1971).

New results are presented for the reactions $\pi^-p \rightarrow m^0n$ at 3.65 GeV/c, where m^0 represents η or η' decaying to $\gamma\gamma$. There were seen 31 η' events over a small background, leading to a branching ratio $(\eta' \rightarrow \gamma\gamma)/(\eta' \rightarrow \text{all}) = 0.020^{+0.008}_{-0.006}$. Over 2000 η events were observed, and the differential cross section exhibits a dip at $-t = 1.5\ (\text{GeV}/c)^2$. (auth)

53004 EXPERIMENTAL CHECK OF CROSSING SYMMETRY IN THE ELECTROMAGNETIC INTERACTION OF LEPTONS. Alles Borelli, V.; Bernardini, M.; Bollini, D.; (and others) (CERN, Geneva. Istituto Nazionale di Fisica Nucleare, Bologna. Univ., Bologna. Laboratori Nazionali, Frascati, Italy). Lett. Nuovo Cim.; 2: No. 7, 376-8(14 Aug 1971).

An experimental check of crossing symmetry in quantum electrodynamics is proposed based on a comparison between timelike and spacelike processes $e^+e^- \rightarrow e^\pm e^\mp$ and $e^+e^- \rightarrow \mu^\pm\mu^\mp$. Theoretical predictions and experimental observations from the Adone colliding-beam facility for the rates of these processes are compared. (L.B.S.)

53005 NEW DETERMINATION OF THE π^- AND ν_μ MASSES. Backenstoss, G.; Daniel, H.; Koch, H.; (and others) (CERN, Geneva). Phys. Lett.; 36B: No. 4, 403-8(20 Sep 1971).

The rest mass of the π^- meson was determined by measurements of the energies of π-mesonic x-rays with Ge(Li) detectors to be (139.549 ± 0.008) MeV (standard deviation). An upper limit of 0.6 MeV was deduced for the rest mass of the μ-neutrino (90% confidence). (auth)

53006 ELECTROPRODUCTION OF SINGLE PIONS NEAR THRESHOLD. Nuthakki, V. P. R. (Univ. of Manchester, Eng.).; Turner, O. T.; Dickinson, B.; (and others). Nucl. Phys.; B31: No. 2, 360-8(1971).

Inelastic electron scattering cross sections from hydrogen were measured near the pion production threshold at electron four-momentum transfers squared of 0.10, 0.14, 0.19, and 0.31 $(\text{GeV}/c)^2$ using a beam of 2 GeV/c electrons from the Daresbury electron synchrotron and a magnetic spectrometer to detect the scattered electron. The results are analyzed phenomenologically, and compared with theoretical calculations, using current algebra, to provide an estimate of the axial-vector form factor. (auth)

Weak

Refer also to abstracts 51896, 53518, and 53609.

53007 ANALYSIS OF RECENT EXPERIMENTS ON THE MUON. Montret, J. C. (Univ., Clermont-Ferrand, France). pp II74-91 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970). (In French).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

Recent experiments to measure the g factor and the elastic scattering of the muon are discussed, and preliminary results of an experiment on the inelastic μ-nucleon scattering are given. (France)

Strong (Baryon-Induced)

Refer also to abstracts 53177, 53240, 53530–53533, 53538, 53539, and 53541.

53008 (LA–4483) FORWARD DIFFERENTIAL CROSS SECTIONS FOR THE REACTION $p + p \rightarrow d + \pi^+$ IN THE RANGE 3.4 TO 12.3 GeV/c. Anderson, H. L.; Dixit, M. S.; Evans, H. J.; (and others) (Chicago Univ., Ill.). [1971]. 119p. Dep. NTIS.

Thesis. Submitted by M. V. Sherbrook.

A missing-mass spectrometer, employing optical spark chambers with automatic vidicon readout, was used to measure the forward differential cross section ($\cos\theta_{\text{c.m.}} \simeq 0.995$) for the reaction $p + p \rightarrow d + \pi^+$ at closely spaced settings of the incident proton momentum in the range $p_0 = 3.4$ to 12.3 GeV/c. The deuterons from the reaction were identified by time-of-flight, and their momentum and angle of emission measured by a reconstruction of the spark chamber tracks. Since the incoming proton momentum was accurately known, the missing-mass associated with deuteron production could be deduced. Single pion production was identified by the appearance of a clear peak in the plot of missing-mass at the pion mass. The data confirm the existence of a prominent peak in the forward cross section at $E_{c.m.} = 3.0$ GeV and show a hitherto unreported shoulder at $E_{c.m.} = 3.7$ GeV. This structure, along with the well known sharp maximum at $E_{c.m.} = 2.2$ GeV may be understood on the basis of a one-pion-exchange model as reflecting the behavior of the $T = 3/2$ isobars in the pion-nucleon scattering. Above $E_{c.m.} = 3.9$ GeV, the cross section decreases monotonically as the –2.5 power of the square of the total c.m. energy, s. This feature reflects the behavior of the πp scattering cross section. The structureless upper energy region can be accommodated within the framework of Regge theory. The cross section dσ/du extrapolated to u = 0 varies as the –3.2 power of s, midway between that expected for N_α and N_γ trajectories. (auth)

53009 STUDY OF THE $\bar{p}p \rightarrow \bar{p}p\, 2\pi^+2\pi^-$ REACTION AT 5.7 GeV/c. Braun, H.; Evrard, D.; Fridman, A.; (and others) (CRNS, Strasbourg). Nuovo Cim.; 4A: No. 4, 703-10(21 Aug 1971).

A study was made of the $\bar{p}p \rightarrow \bar{p}p2\pi^+2\pi^-$ reaction at 5.7 GeV/c for which a cross section of (0.18 ± 0.05) mb was obtained. Abundant Δ and $\bar{\Delta}$ production was observed. A rough estimate of the rate for double-resonance production, i.e. $\bar{p}p \rightarrow \bar{\Delta}^{--}\Delta^{++}\pi^+\pi^-$, is also given. The general features of the $\bar{p}p \rightarrow \bar{p}p2\pi^+2\pi^-$ reaction are interpreted by means of a multiperipheral Regge model slightly modified to take into account the strong Δ and $\bar{\Delta}$ production. (auth)

53010 PRODUCTION OF SLOW π MESONS BY 660-MeV PROTONS IN THE INTERACTIONS WITH PHOTOEMULSION NUCLEI. Kostanashvili, N. I.; Lebedevich, G. I.; Nabichvrishvili, D. S. (Tbilisi State Univ., USSR). Yadern. Fiz.; 13: No. 6, 1243-7(Jun 1971). (In Russian).

21 MeV π^+- and π^--meson production process was experimentally studied on the photoemulsion nuclei at 660 MeV incident protons. The data on relative frequences of π^+- and π^--meson yields and their angular distributions are analyzed in order to obtain information on intranuclear interactions and on the mechanism of the slow π-meson production. (auth)

53011 REACTION $\bar{p}p \rightarrow \bar{p}p\pi^-\pi^+$ AT 12 GeV/c. Borecka, I. (DESY, Hamburg); Drews, G.; Lenkeit, W.; (and others). Nuovo Cim.; 5A: No. 1, 19-55(1 Sep 1971).

From an exposure of the CERN 2 m HBC to a separated $\bar{p}$ beam at 12 GeV/c ~90,000 pictures were obtained. The topological cross sections are reported. A fairly systematic investigation of 1098 events fitting the reaction $\bar{p}p \rightarrow \bar{p}p\pi^-\pi^+$ is presented. A search was also made for the channels $\bar{p}p \rightarrow \pi^-\pi^-\pi^+\pi^+$ and $\bar{p}p \rightarrow \bar{p}\bar{p}pp$. The cross section for $\bar{p}p \rightarrow \bar{p}p\pi^-\pi^+$ is (2.35 ± 0.25) mb. Various experimental distributions are well described by two versions of the one-pion exchange model. In the first one, off-shell corrections are applied by introducing form factors (OPEM), whereas in the other model the exchanged pion is Reggeized (RPEM). Large production of $\Delta^{++}(1236)$ and $\overline{\Delta^{++}}(1236)$ is observed. dσ/dt and $\sigma(\bar{\Delta}\Delta)$ for the reaction $\bar{p}p \rightarrow \overline{\Delta^{++}}\Delta^{++}$ were determined by a maximum-likelihood fit which takes into account the peripheral nature of the interaction: $\sigma(\bar{\Delta}\Delta) = (0.64 \pm 0.07)$ mb. There is evidence for ρ^0 production ((40 ÷ 120) μb) and a suggestion of a peak at 1.72 GeV in the combined mass distribution of the systems $p\pi^+\pi^-$ and $\bar{p}\pi^+\pi^-$. For the 302 events in the double-isobar region 12 independent statistical tensors connected with the joint decay angular distribution were determined. They were compared with the prediction of a simple OPE model with absorptive corrections. The relations among statistical tensors, which follow from the assumption of additivity in quark models, were tested in the Jackson frame. Within the large experimental errors they are found to be satisfied. Since the inclusion of the peripheral effect, neglected in previous experiments, affects the determination of the $\bar{\Delta}\Delta$ cross section, $\sigma(\bar{\Delta}\Delta)$ was re-evaluated for two experiments at 3.6 and 5.7 GeV/c and is (2.4 ± 0.2) mb and (1.45 ± 0.2) mb, respectively. The dependence of the $\sigma(\bar{\Delta}\Delta)$ on the primary momentum agrees with the prediction of the OPE model. (auth)

53012 DIFFRACTION GENERATION OF PIONS BY PROTONS WITH 20.8 GeV/c PULSES IN COMPLEX NUCLEAR EMULSIONS. Azimov, S. A.; Abduzhamilov, Sh.; Saidkhanov, N. Sh.; Chudakov, V. M. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 11, 22-4(1970). (In Russian).

It is postulated that the diffraction dissociation $p \rightarrow p\pi^+\pi^-$ in nuclear emulsions irradiated with $p_0 = 20.8$ GeV/c took place only in a group of nucleon, of heavy nuclei and not in the nucleus as a whole. (R.V.J.)

53013 SMALL-ANGLE PROTON–PROTON SCATTERING CROSS-SECTIONS AT 144 MeV. Jarvis, O. N.; Whitehead, C. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett.; 36B: No. 4, 409-11(20 Sep 1971).

The differential cross section in proton–proton scattering at 144 ± 1.5 MeV was measured over the Coulomb-nuclear interference region. When the present data are included in a phase shift analysis the resultant phase shifts are only slightly changed from their previous values. (auth)

53014 TOTAL CROSS SECTIONS OF π^+, K^+ AND p ON PROTONS AND DEUTERONS IN THE MOMENTUM RANGE 15 TO 60 GeV/c. Denisov, S. P.; Donskov, S. V.; Gorin, Yu. P.; (and others) (Inst. of High Energy Physics, Serpukhov, USSR). Phys. Lett.; 36B: No. 4, 415-21(20 Sep 1971).

Total cross section data are presented for protons, positive pions and positive kaons on protons and deuterons in the momentum range 15 GeV/c to 60 GeV/c in 5 GeV/c steps. (auth)

53015 FURTHER RESULTS ON SMALL-ANGLE ELASTIC PROTON–PROTON SCATTERING AT VERY HIGH ENERGIES. Holder, M. (Technische Hochschule, Aachen); Radermacher, E.; Staude, A.; (and others). Phys. Lett.; 36B: No. 4, 400-2 (20 Sep 1971).

Previous investigations at the CERN Intersecting Storage Rings were extended, improved statistics at three different energies, wider angular range and a better control over systematic errors. Values for the (diffraction) shape parameter b are given. (auth)

53016 NEW RESULTS ON n + p → d + γ, AND TIME-REVERSAL INVARIANCE. Bartlett, D. F.; Friedberg, C. E.; Goldhagen, P. E.; Goulianos, K. (Princeton Univ., N. J.). Contract AT(30-1)-4159. Phys. Rev. Lett.; 27: No. 13, 881-5(27 Sep 1971).

The angular distribution for the reaction n + p → d + γ was measured at neutron energies of 475, 560, 625, and 750 MeV. Results based on 31,000 events at nine scattering angles are reported and compared with existing data for the inverse reaction, γ + d → n + p. The angular distributions are found to agree, as predicted by time-reversal invariance. (auth)

53017 COUNTER EXPERIMENTS FOR THREE-PARTICLE FINAL STATES. Byckling, E.; Kajantie, K. (Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI; No. 342, 1-30(1970).

Several counter experiments designed to measure various dynamical properties of high-energy reactions with three particles in the final state are suggested. Relevant theoretical models and ideas are reviewed. Detector configurations and specifications and estimates of data-gathering rates for each type of experiment are discussed. (auth) (Finland)

53018 OBSERVATIONS ON THE NUCLEAR INTERACTIONS OF COSMIC RAY PIONS AND NUCLEONS AT ENERGIES ≥20 GeV. PART II. THE EXTREMELY COLLIMATED NUCLEAR INTERACTIONS. Lal, S.; Raghaven, R.; Rangaswamy, T. N.; (and others) (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A; 73: No. 4, 170-8(Apr 1971).

Detailed features of extremely collimated nuclear interactions induced by cosmic ray particles in carbon and brass are presented. These extremely collimated nuclear interactions seem to be preferentially induced by pions rather than by nucleons; also the relative frequency of these seems to be less when brass is used as target compared to the case with carbon as target. The distribution of multiplicities of secondary particles emitted in the forward direction show certain regularities in the case of interactions induced by charged primaries. Observations on the γ-rays associated with these events give support to the interpretation that in these inelastic collisions pions are produced in pairs in the forward direction with low transverse momentum. It is suggested that such a low energy di-pion system could be the same as found in the so-called ABC effect. (auth)

53019 MEASUREMENTS OF ANTIDEUTERON ABSORPTION AND STRIPPING CROSS SECTIONS AT THE MOMENTUM 13.3 GeV/c. Denisov, S. P.; Donskov, S. V.; Gorin, Yu. P.; (and others) (Inst. for High Energy Physics, Serpukhov, Moscow). Nucl. Phys.; B31: No. 2, 253-60(1971).

The absorption cross sections of antideuterons with the momentum P = 13.3 GeV/c by Li, C, Al, Cu, and Pb nuclei were measured. Antiproton stripping of antideuterons was registered and its cross section for C, Al, and Cu was defined. The binding energy of antideuteron is found to be $\epsilon_{\bar{d}} = 2.4 \pm 0.6$ MeV by measuring the angular distribution of antiprotons from stripping. (auth)

53020 STUDY OF PROTON–ANTIPROTON BACKWARD ELASTIC SCATTERING BETWEEN 1.12 AND 1.36 GeV/c. Vallet, S. (Univ., Neuchatel, Switzerland); Bogdanski, M.; Gay, J. B.; (and others). Lett. Nuovo Cim.; 2: No. 5, 261-4(31 Jul 1971). (In French).

A study is made of backward elastic $\bar{p} + p$ interactions at 1.12

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to 1.36 GeV/c in a bubble chamber. The differential cross sections are shown for this interaction. In these cross sections a marked backward peak is found which corresponds to the meson T(2195). (J.F.P.)

53021 OBSERVATION OF ANTIHELIUM-3. Antipov, Yu. M.; Denisov, S. P.; Donskov, S. V.; (and others) (Inst. of High Energy Physics, Serpukhov, Moscow). Nucl. Phys.; B31: No. 2, 235-52(1971).

$^3\overline{He}$ nuclei were observed in the negative beam, produced by 70 GeV protons on an Al target. Five $^3\overline{He}$ were identified among 2.4×10^{11} particles that passed through the apparatus. Scintillation and Cherenkov counters were used to measure the electrical charge and velocity in particles. The mass of $^3\overline{He}$ is found to be $M_{^3\overline{He}} = (1.00 \pm 0.03)3m_p$, the charge is $z = (0.99 \pm 0.03)2e$. The ratio of differential production cross sections of $^3\overline{He}$ ($P = 20$ GeV/c) and π^- ($P = 10$ GeV/c) equals 2×10^{-11}. This corresponds to antihelium-3 production cross section $d^2\sigma_{^3\overline{He}}/d\Omega dP = 2.0 \times 10^{-35}$ cm²/sr · GeV/c per Al nuclei and 2.2×10^{-36} cm²/sr · GeV/c per nucleon. (auth)

53022 SLOPE PARAMETER OF THE ELASTIC p–p DIFFERENTIAL CROSS-SECTION AT 50 GeV. Chernev, Kh. M.; Ikov, N. L.; Markov, P. K.; Trushkov, S. N.; Zayachki, V. I. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 24: No. 2, 171-3(1971).

Four photoemulsion stacks were used to detect secondary particles from elastic p + p scattering at 50 GeV. The differential cross sections were determined at ten angles in the range of small momentum transfer. The differential cross sections and the energy dependence of the slope parameter are shown. (J.F.P.)

Strong (Meson-Induced)

Refer also to abstract 53752.

53023 (IAE-1975) ELASTIC (π^-p)-SCATTERING AT 4.5 GeV/c. Kutlina, O. I.; Mukhin, K. N.; Romantseva, A. S.; Sulkovskaya, M. M. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

By use of a hydrogen bubble chamber the differential cross section for elastic (π^-p) scattering was measured at 4.33 GeV π^- meson energy. The total cross section was 6.2 ± 0.6 mb. The organization of the experiment and the method of processing the results are discussed. (K.S.W.)

53024 (IFA-HE-74) PRODUCTION OF A NEW BOSON RESONANCE. Sabau, M. (Institutul de Fizica Atomica, Bucharest (Romania)). 1970. 5p. Dep. NTIS (U. S. Sales Only).

The production of a new four-particle boson resonance $X^+ = (KK\pi\pi^+)$ in the reactions $\pi^+ + p \rightarrow p + K^+(K^-) + K^0 + \pi^+ + \pi^-(\pi^+)$ at 8.04 GeV/c in a hydrogen bubble chamber is discussed. The parameters obtained for this resonance are $M = 2820 \pm 10$ MeV, $\Gamma = 50 \pm 10$ MeV, and $I = 1$ or 2. The production cross section is estimated, and the most probable decay mode is $X^+ \rightarrow 2K + \pi$. (J.F.P.)

53025 ANGULAR DISTRIBUTION OF TRACKS IN STARS PRODUCED BY 60-GeV π MESONS ON HEAVY NUCLEI OF PHOTOEMULSION. Goryachikh, A. A.; Takibaev, Zh. S.; Titova, N. S.; Shalagina, E. V. (Kazakh State Univ., Alma-Ata, USSR). Yadern. Fiz.; 13: No. 6, 1267-9(Jun 1971). (In Russian).

Angular distributions of thin, grey and black tracks in splittings produced by 60-GeV π mesons are studied. The distributions obtained are compared with the angular distributions of tracks from stars produced by 2.26 and 19.5 GeV protons. (auth)

53026 POSSIBLE EXISTENCE OF $\pi^-\gamma$ RESONANCE WITH MASS 270 MeV. Budagov, Yu. A.; Vinogradov, V. B.; Volod'ko, A. G.; (and others) (Joint Inst. for Nuclear Research, Moscow). JETP Lett. (USSR) (Engl. Transl.); 13: No. 12, 471-3(20 Jun 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 12, 665-8(20 Jun 1971).

An experimental indication of the existence of a new meson resonance produced in the reaction $\pi^- + p \rightarrow \pi^- + p + 2\gamma(3\gamma)$ at 5 GeV/c in a propane bubble chamber was found. A narrow peak at $M = 270$ MeV was observed in the effective-mass spectrum of the $\pi^-\gamma$ system produced in this reaction. The width of this resonance was found to be 13 ± 5 MeV. (J.F.P.)

53027 WHAT'S BEYOND $\rho\omega\phi$. Davier, Michel (European Organization for Nuclear Research, Geneva). pp II45-57 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

After reviewing briefly the theories predicting new vector mesons, production and decay modes of $I = 1$ vector mesons are considered. Experimental results of searches for higher-mass neutral vector mesons with charge conjugation $C = -1$ in photoproduction and in hadronic production are presented. There is no experimentally observed photoproduced vector meson around 1250 MeV, but there may be an effect near 1500 MeV in the $\pi^+\pi^-$ and $\pi^+\pi^+\pi^-\pi^-$ mass spectra. (France)

53028 MEASUREMENTS OF SPIN ROTATION PARAMETERS A AND R IN PION–PROTON SCATTERING AT HIGH ENERGIES. Van Rossum, L. (CEA, Saclay, France). pp III44-55 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

An experiment designed to measure the spin rotation parameters A and R in πp interactions at energies above the resonance region is discussed. The parameters were measured in a double scattering experiment using a polarized target. Preliminary data at 6 GeV/c are compared to various predictions, mostly based on Regge-pole models. (France)

53029 BACKWARD SCATTERING. Bellettini, G. (Istituto Nazionale di Fisica Nucleare, Pisa, Italy). pp III158-66 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

Experimental data on backward $\pi^\pm$p elastic scattering at high energies are interpreted in terms of baryon exchange in the u-channel. Further developments are presented, based on polarization measurements, backward π^-p charge-exchange data and models including Regge poles and cuts. Backward kaon scattering and associated production data are also discussed in terms of baryon exchange models. (France)

53030 MEASUREMENT OF MOMENTUM OF PIONS WITH ENERGY 60 GeV IN NUCLEAR PHOTOEMULSIONS. Voinov, V. G.; Inchin, A. S.; Strel'tsov, I. S. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 4, 85-9(Jul-Aug 1970). (In Russian).

Multiple scattering was measured on 54 pion tracks in eight layers of nuclear photoemulsion of BR-2 type, irradiated by a π^- beam with an energy of 60 GeV from the Serpukhov accelerator. The length of each track was not less than 5 cm. It was shown that it is possible to measure in photoemulsion the momenta of particles with energy of the order of 60 GeV. It is recommended to exclude spurious scattering and noise by the method of correlation moments for greater efficiency. (tr-auth)

53031 CORRELATED PRODUCTION OF PROTON PAIRS IN THE PION–CARBON INTERACTION AT MOMENTUM = 4 GeV/c. Azimov, S. A.; Azimova, M.; Igamberdiev, K. R.; Rizaev, Khx. A.; Yuldashev, A. A. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 11, 25-6(1970). (In Russian).

The results of a search for correlated proton pair production are described for the interaction of π^- mesons with a momentum of 4 GeV/c with a carbon nucleus. A 24-liter propane bubble chamber was used, and stars on the photographs were chosen which were formed by the original π^- mesons with two or more tracks. The observed correlation of proton pair production in events with two tracks to some degree is reflected in the azimuthal angular distribution of these protons. (auth)

53032 EXPERIMENTAL INVESTIGATION ON HELICITY CONSERVATION. Kemp, D. (Univ. of Durham, Eng.); Scarrott, S. M.; Contri, R.; (and others). Lett. Nuovo Cim.; 2: No. 9, 471-80(28 Aug 1971).

The s- and t-channel helicity conservation is investigated for processes that are possibly described by pomeron exchange, using data from two bubble chamber experiments. The reactions studied are (1) $\pi^+d \rightarrow d\pi^+\pi^+\pi^-$ at 11.7 GeV/c; (2a) $\pi^+n \rightarrow n\pi^+\pi^+\pi^-$ at 11.7 GeV/c; and (2b) $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ at 11.2 GeV/c. Two types of selection were used for analysis of the data: the longitudinal phase-space plot and the A1 mass region. The longitudinal phase-space selection shows indication of s-channel helicity conservation, in agreement with ρ photoproduction. The A1 selection shows an incompatibility with helicity conservation in either s- or t-channel. (L.B.S.)

53033 OBSERVATION OF γ-RAYS FROM THE EXCITED STATES OF HYPERNUCLEI. Bamberger, A. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Faessler, M. A.; Lynen, U.; (and others). Phys. Lett.; 36B: No. 4, 412-14(20 Sep 1971).

The spectroscopy of γ-rays following the K^- capture in ^{6}Li and ^{7}Li gave an evidence for the hypernuclear γ transitions ascribed to excited states of $^4_\Lambda$H or $^4_\Lambda$He. (auth)

53034 CHARGE EXCHANGE AND NON-CHARGE EXCHANGE SCATTERING OF 270 MeV K^+-MESONS IN NUCLEAR EMULSIONS. Sood, P. M. (Panjab Univ., Chandigarh, India). Proc. Indian Acad. Sci., Sect. A; 73: No. 4, 164-9(Apr 1971).

The charge exchange and non-charge exchange scatterings of ~270 MeV K^+-mesons were studied in G-5 nuclear emulsions. The angular distributions are in conformity with the predictions of phase shift analysis at this energy. (auth)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 53422.

General

Refer also to abstract 53834.

53035 (AD-712740) PROBLEMS IN SOFT-PION AND REGGE THEORY. Final Technical Report. Leung, George Y. (Southeastern Massachusetts Univ., North Dartmouth. Dept. of Physics). 14 Sep 1970. 30p. (AFOSR-70-2401-TR). NTIS.

The objective is to investigate several problems in high-energy and elementary-particle physics of current interest and to attempt to gain a better understanding of these problems. The investigations in this field are normally divided into theoretical and experimental studies. For some of the proposed problems of investigations, there is no lack of experimental data, and constant comparisons with the experimental results guide the direction of pursuit. An outline of these studies is presented. (auth)

53036 (DESY-71/31) REGGE POLES FOR LARGE COUPLING CONSTANTS. [PART] II. Cheng, Hung; Wu, Tai Tsun (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1971. Contract AT(30-1)-4101. 32p. Dep. NTIS.

Since the Pomeron is defined to be the leading singularity of the "potential," and it is found that a high-energy particle resembles an expanding black disk if this singularity is located at $J > 1$, as a model the generation of such a singularity by the ladder diagrams in ϕ^3-theory is studied. It is found that when the coupling constant is sufficiently large, there are Regge poles located at $J > 1$. Thus the Pomeron in this model is a Regge pole with $\alpha(0) > 1$. This conclusion is reached by solving the Bethe-Salpeter equation to determine, in the strong coupling limit, the positions of the Regge (or Toller) poles at $t = 0$. A family of approximately equi-spaced Toller poles is found. The position of the leading singularity, but not the spacing, depends critically on whether the exchanged particle is massless or massive. Some numerical results are presented. (auth)

53037 (NYO-4204-17) FEYNMAN'S RELATION FOR PARTICLE PRODUCTION NEAR THE BOUNDARY OF PHASE SPACE. Elitzur, Moshe (Rockefeller Univ., New York). [1970]. Contract AT(30-1)-4204. 11p. Dep. NTIS.

Feynman's relation for the one-particle inclusive experiment at the edge of the fragmentation region is derived using only quasi two-body amplitudes and single Regge exchange. A similar relation for two particles inclusive experiments is also derived. (auth)

53038 (UCRL-20655) PROCEEDINGS OF THE WORKSHOP ON PARTICLE PHYSICS AT INTERMEDIATE ENERGIES HELD ON MARCH 29-30, 1971 AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CALIFORNIA. Field, R. D. Jr. (ed.) (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1971. 467p. (CONF-710316). Dep. NTIS.

Eighteen papers are included; separate abstracts are prepared for sixteen. Two papers were previously abstracted for NSA; see 25: 36502 and 43565. (L.B.S.)

For abstracts of individual papers see: 53102, 53130-53133 53179-53183, and 53428-53433.

53039 EIGHTH ANNUAL EASTERN THEORETICAL PHYSICS CONFERENCE PROCEEDINGS, SYRACUSE, NEW YORK, OCTOBER 10-11, 1969. Rohrlich, F. (ed.). Syracuse, N. Y.; Syracuse University (1969). 329p. (CONF-691033).

The conference included 12 papers two of which were abstracted previously in NSA. For an abstract of these papers see abstract numbers 24: 30871 and 25: 12175. Separate abstracts were prepared for nine papers. The other paper was outside the scope of NSA. (J.F.P.)

53040 ANALYTICITY IN THE COUPLING CONSTANT AND THE PADE APPROXIMATION. Simon, Barry (Princeton Univ., N. J.). Contract AF49(638)1545. pp 167-95 of Eighth Annual Eastern Theoretical Physics Conference Proceedings. /Rohrlich, F. (ed.). Syracuse, N. Y.; Syracuse Univ. (1969).

From eighth eastern theoretical physics conference; Syracuse, N. Y. (10 Oct 1969). See CONF-691033.

The topics covered in this review are continuation in the coupling constant, choice of the model, the Bender-Wu and Simon treatments of the anharmonic oscillator, coupling constant analyticity, Padé approximants, Pade approximants for the anharmonic oscillator, Pade approximants and the Feynman series, and Pade computations in particle physics. (J.F.P.)

53041 DISPERSION THEORY AND CURRENT ALGEBRA. Lam, Yuk-ming P. (Univ. of Chicago). Phys. Rev., D; 4: No. 2, 517-32(15 Jul 1971).

Lorentz invariance and the basic assumption in dispersion theory, namely, that the matrix element of a retarded or advanced commutator of local fields is an analytic function of the energy variable, are seen to determine the method of handling the dispersion integral, and to require the matrix element to consist of terms, each of which is a product of at most two poles or an integral thereof. This method is used to study current-algebra commutators, with the consequence that the widely employed assumption of single-pole dominance for the spin-1 parts of vector or axial-vector currents is inconsistent with current algebra. Some aspects of the K_{l3} form factors are also discussed. (auth)

53042 HYPERSPHERICAL FUNCTIONS FOR THREE PARTICLES. Efros, V. D. Yadern. Fiz.; 13: No. 6, 1318-32(Jun 1971). (In Russian).

Complete set of independent hyperspherical functions with fixed L and M, forming bases of irreducible representations of the permutation group for three particles is constructed in a closed form. (auth)

53043 TACHYON MECHANICS AND CLASSICAL TUNNEL EFFECT. Wimmel, H. K. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Lett. Nuovo Cim.; 2: No. 7, 363-7 (14 Aug 1971).

A consistent, classical mechanics of charged tachyons in electromagnetic fields is formulated. The Lorentz-convariance properties of the tachyon observables are determined correctly and in agreement with quantum-field theory results. A new effect specific to tachyons, the classical tunnel effect, is also demonstrated. (L.B.S.)

53044 INTERACTION TIME EVALUATION. Papp, E. (Polytechnic Inst., Cluj). Nuovo Cim.; 5B: No. 1, 119-33(11 Sep 1971).

It is proposed to utilize the operator $T = -i(\partial/\partial\omega)$, which is conjugate to the energy ω, as a formal time operator in order to obtain, in the case of the nonrelativistic collision of spinless particles, an observable time-shift evaluation. Evaluations of the time shift for various cases are performed. (auth)

53045 SUM RULES FOR INCLUSIVE REACTIONS AND DISCONTINUITY FORMULAE. Veneziano, G. (CERN, Geneva). Phys. Lett.; 36B: No. 4, 397-9(20 Sep 1971).

The basic discontinuity formula, generally regarded as the building block of unitarity, is shown to be equivalent to a set of linear sum rules, plus the existence of isolated, factorizable poles in the physical region. (auth)

53046 HIGH ENERGY PHYSICS INDEX. VOLUME 9, NO. 14, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 74p.

53047 HIGH ENERGY PHYSICS INDEX. VOLUME 9, NO. 13, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 78p.

Electromagnetic

Refer also to abstracts 52990, 52995, 53273, 53276, 53345, 53347, and 53618.

53048 (DESY-71/30) PRODUCTION OF PION PAIRS IN ELECTRON COLLIDING BEAMS. Cheng, Hung; Wu, Tai Tsun (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1971. Contract AT(30-1)-4101. 35p. Dep. NTIS.

Pionization in electron-electron (or electron-positron) colliding beams is studied in detail for the dominant case where the produced pions have nearly equal but opposite transverse momenta. Accurate measurements in this case, without detecting the outgoing electrons, can be used to determine all amplitudes and phases for $\gamma + \gamma \rightarrow \pi^+ + \pi^-$. The results are obtained directly from Feynman diagrams and thus inaccuracies due to Weizsäcker–Williams approximation are avoided. All the formulas are equally applicable to the production of any pair of spinless bosons in electron–electron (or electron–positron) colliding beams. (auth)

53049 (DESY–71/32) SCATTERING OF A CHARGED VECTOR MESON IN A STATIC FIELD AT HIGH ENERGIES. Cheng, Hung; Wu, Tai Tsun (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1971. Contract AT(30-1)-4101. 28p. Dep. NTIS.

The scattering of a charged vector meson (without the anomalous magnetic moment) in a static field is studied. The scattering amplitude for such a process is obtained explicitly in the case of a central field. It is found that the simple exponentiation form of the eikonal approximation does not occur. (auth)

53050 (DESY–71/36) DIFFRACTIVE INELASTIC PROCESSES AT EXTREMELY HIGH ENERGIES. Cheng, Hung; Wu, Tai Tsun (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1971. 12p. Dep. NTIS.

At infinite energy, it is predicted that for all diffractive processes, initiated by either hadrons or photons, the integrated cross section approaches infinity and dips appear in the angular distribution. Also results are given for pionization, and the theoretical basis is discussed. (auth)

53051 (JINR–P2–5752) EFFECTS OF MULTIPLE RESCATTERING IN THE PROCESSES OF THE CHARGE EXCHANGE TYPE. Gevorkyan, S. R.; Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

All multiple-scattering contributions to the cross sections of charge-exchange-type processes from nuclei are summed in a simple closed expression. This expression differs from the quasi-classical one by including the elastic cross sections in the attenuation factor. Cross sections for photoproduction of charged mesons, $\pi^\pm$ charge exchange, and Δ^{++} production by protons from ^{27}Al are considered. (auth)

53052 MULTIPLE e.m. PROCESSES IN HIGH-ENERGY e^-e^{-+} COLLISIONS. Greco, M. (CNEN, Frascati, Italy). Nuovo Cim.; 4A: No. 4, 689–70(21 Aug 1971).

The production of electron and muon pairs is studied in high-energy $e^-e^\pm$ collisions. Total and differential cross sections are discussed with special regard to experimental implications. Hadron production *via* photon-photon scattering is also studied, and suggestions are made for present and near future experiments. (auth)

53053 CLOSED-FERMION-LOOP CALCULATIONS IN CHIRAL MODELS OF ELECTROMAGNETIC PROCESSES. Aviv, R.; Sawyer, R. F. (Univ. of California, Santa Barbara). Phys. Rev., D; 4: No. 2, 451–7(15 Jul 1971).

The amplitudes involving two external γ's and an arbitrary number of soft π mesons emitted from a closed nucleon loop have been calculated in a model with a formally conserved (neutral) axial-vector current. The results violate the formal chiral symmetry of the underlying Lagrangian, but in a way that has the following simple group-theoretic interpretation stated in terms of an effective Lagrangian L_{eff}: Instead of finding $\delta L_{eff} = 0$ under those chiral variations which leave the electromagnetic couplings invariant, δL_{eff} is found to be independent of the chirally transforming fields. If the group-theoretic principle is abstracted from the detailed calculation it leads to predictions for the processes $\gamma + \gamma \rightarrow$ (an odd number of pions) which should hold true in a wide class of chiral models. The generalization is given to a quark-loop calculation in a theory invariant under the neutral transformations from $SU(3) \otimes SU(3) \otimes U(1)$, and the results for $\gamma\gamma \rightarrow$ pions are unchanged. (auth)

53054 SCALAR FIELDS OF LOW DIMENSION: EVIDENCE FROM ELECTROMAGNETIC MASS DIFFERENCES. Brown, Stanley G. (Univ. of California, Los Angeles). Phys. Rev., D; 4: No. 2, 600–2(15 Jul 1971).

The size of the mass splittings within isomultiplets suggests that (1) the usual strong-interaction Hamiltonian needs to be modified, or (2) there are scalar fields of dimension ≤ 4 belonging to $SU(3) \times SU(3)$ representations other than (1, 1) and $(\bar{3}, 3) + (3, \bar{3})$, or (3) there is a large electromagnetic renormalization of the strong interactions. (auth)

53055 FORWARD COMPTON SCATTERING AMPLITUDE AS A SIMULTANEOUS ANALYTIC FUNCTION OF COMPLEX PHOTON MASS AND ENERGY. Suri, Ashok (Stanford Univ., Calif. Univ. of California, Santa Cruz). Phys. Rev., D; 4: No. 2, 570–99(15 Jul 1971).

The analytic structure of the virtual forward Compton scattering amplitude as a function of one and two complex variables is investigated for various combinations of variables which involve the virtual photon mass. This is done both by using the Deser–Gilbert–Sudarshan representation and by using the Feynman perturbation theory. The role and significance of complex Landau singularities is discussed. In general these are branch points, but it is found that at t = 0 some of these become poles. The effect of these complex singularities and of overlapping cuts on the ordinary single-variable dispersion relations and the mass extrapolations in the vector-meson-dominance model is explained. Using the Cutkosky discontinuity formula for Feynman graphs, the analytic structure of the discontinuities across various normal threshold cuts of the non-Born-term part of this amplitude is deduced. It is found that the two-variable analyticity of the amplitude implies a single-variable analyticity for these discontinuities. It is shown that in general the inelastic structure functions W and $\overline{W}$ cannot be expected to have a simply determinable analytic structure. But under certain conditions W and W can be identified with boundary values of the discontinuities across the s- and u-channel normal threshold cuts in the virtual forward Compton scattering amplitude, respectively. This is used to show that the contribution to W and W from certain types of Feynman graphs under certain conditions are analytic functions of one complex variable, and only for such cases can one use crossing symmetry to relate the inelastic-electron-scattering structure functions and the annihilation structure functions. The motion of the Landau singularities of νW_2 is shown to provide a possible explanation for its observed rapid approach to "scaling" for finite but large final-state masses. (auth)

53056 CLASSICAL DESCRIPTION OF SPINNING PARTICLES. Ellis, J. R. (Univ. of Sussex, Eng.). J. Phys., A (London); 4: No. 4, 583–96(Jul 1971).

On the basis of a calculation for the force and couple exerted on a moving point dipole given previously, a consistent description of classical spin for particles possessing charge and dipole moment is discussed. (auth) (UK)

53057 PHOTOPRODUCTION OF NEUTRINO PAIRS ON POLARIZED ELECTRONS IN AN ELECTROMAGNETIC FIELD. Loskutov, Yu. M.; Zakhartsov, V. M. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 11, 45–9(1970). (In Russian).

The photoproduction of neutrino–antineutrino pairs on polarized electrons was studied with the calculation of spin state of electron recoil. It is shown that in the emission of the neutrino pair there results a beam of polarized electrons. (tr-auth)

53058 FORM FACTOR AND VIRTUAL-COMPTON-SCATTERING AMPLITUDE IN THE KIKKAWA–SATO MODEL (DUAL-RESONANCE MODEL OF HADRON WITH GAUGE BOSONS). Niegawa, A. (Kyoto Univ.). Nuovo Cim.; 4A: No. 4, 883–903 (21 Aug 1971).

Using the dual-resonance model of Kikkawa and Sato, the contributions of the one-closed-loop graph to the electromagnetic form factor and the virtual-Compton-scattering amplitude of the $I = 1$, $I_3 = 1$, 0^+ meson are calculated. It is shown that the resulting form factors behave like $1/(-t)$ as $t \rightarrow -\infty$, and the virtual-Compton-scattering amplitude A satisfies the Bjorken's scaling law and has the fixed-pole structure required by the Fubini–Gell-Mann sum rule. Obviously this model is gauge invariant. (auth)

53059 RADIATIVE CORRECTIONS AND POLARIZATION EFFECTS IN COMPTON SCATTERING. Ryskin, M. G.; Frolov, G. V. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 13: No. 6, 1270–8(Jun 1971). (In Russian).

The contribution to the Compton scattering cross section on polarized electrons due to photon linear polarization is calculated. This contribution appears due to radiative corrections. The obtained result for asymmetry is by an order of magnitude more than the corresponding one for the case of unpolarized photons, however, it cannot explain recent Bock experiments even at 100% photon polarization. Similar calculations are performed for the nonrelativistic case. The results are applicable for the scattering of low-energy photons by any system with spin $1/2$, particularly, for the photon-hadron scattering. (auth)

53060 ELECTRON–POSITRON PAIR ANNIHILATION IN RENORMALIZABLE THEORY OF WEAK INTERACTIONS. Guliev, N. A.; Dzhafarov, I. G. (Inst. of Physics, Baku). Yadern. Fiz.; 13: No. 6, 1284–7(Jun 1971). (In Russian).

Two-particle electron-positron pair annihilation in a renormalizable theory of weak interactions is considered. Total production cross sections for proton–antiproton pair and pion pair are calculated. The energy behavior of the cross section indicates that the contribution from the weak interactions according to the model is more than that from the conventional one-photon mechanism. (auth)

53061 CURRENT ALGEBRA AND π-MESON ELECTROPRODUCTION ON NUCLEONS. Kulish, Yu. V. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 13: No. 6, 1301-8(Jun 1971). (In Russian).

Meson(π) electroproduction on nucleons near the threshold is considered in the framework of the PCAC hypothesis and current algebra. Only the non-Born part of the amplitude is extrapolated off the π-meson mass shell ($q = 0$). In the processes of the π-meson electroproduction on protons the cross section is most sensitive to the axial form factor of nucleon. The agreement with the experiment in the π-meson 3 momentum region is obtained up to the resonance $N^{*(1236)}$ at the axial form factor corresponding to the data from the neutrino experiment. (auth)

53062 RELATIVISTIC RECONSTRUCTION OF THE $\gamma + N \rightarrow \pi + N$ PHOTOPRODUCTION AMPLITUDE AT ARBITRARY ANGLE. Doan, Nhuong (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 6, 1314-17(Jun 1971). (In Russian).

To adopt the solution of the conspiracy relation (pole-conspirator or cut-conspirator) one needs to determine the forward photoproduction amplitudes. Measurements in experiments with polarized target are considered that are necessary to reconstruct unambiguously the photoproduction amplitude at arbitrary angle, including zero, with account of the specific spin rotation. (auth)

53063 POSSIBILITY OF DETERMINING THE SPIN AND PARITY OF THE X^0 (960) MESON IN ELECTROMAGNETIC INTERACTIONS. Zaslavskii, A. N.; Khoze, V. A. JETP Lett. (USSR) (Engl. Transl.); 13: No. 12, 500-3(20 Jun 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 12, 706-10(20 Jun 1971).

A theoretical discussion is given of the determination of the spin and parity of the X^0 meson in photoproduction of X^0 on a nucleus with spin 0, in production of the X^0 meson in the interactions $e^+e^- \rightarrow X^0(960) + \rho^0(\gamma)$ in colliding beams, and in the decay $X^0(960) \rightarrow \rho^0 + e^+ + e^-$. (J.F.P.)

53064 ELASTIC PHOTON–DEUTERON SCATTERING. Alimov, A. D. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz.; 13: No. 6, 1225-9(Jun 1971). (In Russian).

The method of relativistic impulse approximation is applied to investigate γ-quanta-deuteron elastic scattering. Numerical analysis is performed for 90, 110, 140° scattering angles within 140 to 430 MeV energy region of the incident γ quantum. Calculation results with the use of different models of the deuteron form factors show the necessity of additional experiments on elastic γd scattering aiming to check the conclusions of the theory. (auth)

53065 EMPIRICAL TEST OF TENSOR-MESON DOMINANCE. Budini, P.; Calucci, G. (International Centre for Theoretical Physics, Trieste, Italy. Univ., Trieste, Italy). Lett. Nuovo Cim.; 1: No. 26, 1071-4(26 Jun 1971).

The $e^+ + e^- \rightarrow \rho + f$ interaction is suggested to test the hypothesis that the spin-two meson gives rise to tensor-meson dominance in gravitational interactions of hadrons. The amplitude for this process is calculated under certain assumptions for the $\rho - f$ vertex and coupling constant. (L.B.S.)

53066 EXISTENCE PROOF FOR SOLUTIONS OF CLASSICAL TWO-ELECTRON PROBLEMS. Flume, R. (Univ., Hamburg). Commun. Math. Phys.; 20: No. 2, 111-22(1971). (In German).

A method proving the existence of solutions of the classical relativistic equation of motion of an electron in a given electromagnetic field is extended to the two-electron problem. A lower bound of the impact parameter assures the applicability of the method. (auth)

53067 CONCERNING THE CLASSICAL THEORY OF MAGNETIC CHARGE. Strazhev, V. I. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 1, 106-12(1971). (In Russian).

As a criterion for the theory of magnetic charge the possibility of limiting transition to the electrodynamics of electrically and magnetically charged particles under conditions of universality of the ratio g/e, equivalent to the electrodynamics of particles with one effective charge $q = \sqrt{e^2 + g^2}$. The approach using two independent potentials does not satisfy this criterion in contrast to the approach based upon the introduction of a line of singularity of one independent potential. From a study of the synthesis of classical theory of magnetic charge, it follows that an introduction of magnetic charge is not connected with an increase of the number of degrees of freedom for the magnetic field. (tr-auth)

53068 HARD BREMSSTRAHLUNG IN e^+e^- COLLISIONS. Parisi, G. (CNEN, Frascati, Italy); Zirilli, F. Lett. Nuovo Cim.; 2: No. 8, 395-6(21 Aug 1971).

It is shown that there is an important contribution to the total production cross section for e^+e^- interactions due to the process $e^+e^- \rightarrow e^+e^-\gamma$ where the final photon is hard and emitted with a large angle. (L.B.S.)

53069 BEST UPPER AND LOWER BOUNDS FOR THE PION FORM FACTOR BELOW THRESHOLD AND FOR ITS DERIVATIVE AT $t = 0$. Raszillier, I. (Inst. of Physics, Bucharest). Lett. Nuovo Cim.; 2: No. 7, 349-52(14 Aug 1971).

An attempt is made to extract the maximum of information on the pion form factor F(t) by exploiting the experimental data about its modulus $|F(t)|$ at $t \geq 4\ m^2$ from $e^+e^- \rightarrow \pi^+\pi^-$ experiments. (L.B.S.)

53070 LOW-ENERGY THEOREMS FOR PHOTON AND GRAVITON SCATTERING ON A TARGET OF ARBITRARY SPIN. Muradyan, R. M.; Chavleishvili, M. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 8: No. 1, 16-22 (Jul 1971). (In Russian).

A simple way of deducing old and new low-energy theorems is proposed for the Compton effect and the scattering of gravitons on a target with arbitrary spin. The procedure is based on using regularized helicity amplitudes free of the kinematical singularities and satisfying dispersion relations. The purely kinematical nature of low-energy theorems is stressed. (auth)

53071 Ve RENCONTRE DE MORIOND SUR LES INTERACTIONS ELECTROMAGNETIQUES. (Fifth Moriond Conference on Electromagnetic Interactions). Proceedings of the International Conference Held at Meribel-les-Allues, France, March 9–20, 1970. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970). 371p. (In French and English). (CONF-700325).

Separate abstracts were prepared for 28 of the 29 papers presented. The remaining paper was previously abstracted in NSA as 24: 42998. (C.E.S.)

For abstracts of individual papers see: 52995–52998, 53007, 53027–53029, 53072–53077, 53134–53139, 53159, 53160, 53184–53188, and 53296.

53072 REVIEW OF INELASTIC ELECTRON SCATTERING. Callan, C. (Inst. for Advanced Study, Princeton, N. J.). pp II36-44 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

Inelastic electron scattering is reviewed. A naive model calculation for the ratio of cross sections for absorption of a longitudinal or transverse (virtual) photon by a spin-½ target implies $\sigma_L/\sigma_T \sim 0$ at high energy. Experimental data, algebraic arguments and Feynman's parton model are discussed. (France)

53073 IMPLICATIONS OF GAUGE INVARIANCE FOR PHOTOPRODUCTION REACTIONS. Salin, Ph. (Univ., Bordeaux). pp II147–55 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970). (In French).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

Implications of gauge invariance for photoproduction reactions are reviewed, using helicity amplitudes. The example of photoproduction on a scalar particle with zero charge is studied to develop the arguments presented. An explicit theoretical formulation of the scattering amplitudes is given. (France)

53074 VECTOR-MESON DOMINANCE. Schmidt, W. (Kernforschungszentrum, Karlsruhe, Ger.). pp II156-61 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

The statements (space-time picture) that the range of interactions of high energy photons with hadrons increases linearly with energy and that this interaction distance exceeds nuclear dimensions are discussed. Then the relation between electroproduction of pions and ρ-production by pions is studied. (France)

53075 PHOTOPRODUCTION OF PIONS FROM NUCLEI. Hoegaasen, H. (Univ. of Oslo). pp II162-7 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

Starting with the nuclear optics model, some arguments in favor of the vector dominance model are presented. It is concluded that the asymmetry for high-energy photoproduction of π^+ from nuclei will decrease with nucleon number. (France)

53076 VECTOR MESON DOMINANCE IN PHOTO- AND ELECTROPRODUCTION. Schildknecht, D. (Deutsches Elektronen-Synchrotron, Hamburg). pp II168-92 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

Recent developments in vector meson dominance in photo- and electroproduction are discussed. Electro- and photoproduction of pions are studied to investigate which frame of reference is best to make the smoothness assumption of the vector dominance model (VDM). Photoproduction of vector mesons from nucleons and nuclei and total photoproduction cross sections are in good agreement with VDM predictions, but available total electroproduction cross section data are not. (France)

53077 TWO REMARKS CONCERNING POLARIZATION MEASUREMENTS FOR TWO-PARTICLE REACTIONS. Schmidt, W. (Kernforschungszentrum, Karlsruhe, Ger.). pp II124-31 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

First it is demonstrated, with the help of two examples, that for every reaction there exists two equivalent experimental set ups to obtain the identical polarization information (assuming parity conservation). Then a simple prescription is discussed for separating natural and unnatural parity exchange in the limit $s \rightarrow \infty$, applicable to any crossed channel and for any process with arbitrary spins of the particles. (France)

53078 ELECTROMAGNETIC INTERACTIONS OF BARYONS IN THE THEORY OF SCHWINGER. Masleev, N. N. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 4, 40-4(Jul-Aug 1970). (In Russian).

On the basis of the previously obtained equation for baryons, representing the connected states of fermion and boson fields, the electromagnetic interactions of baryons are studied. Expressions for the electromagnetic form factors and values of magnetic moments of $\frac{1}{2}^+$ baryons are obtained. The values of the magnetic moments are in good agreement with experimental results and with theoretical results obtained on the basis of the SU(6) group and quark models. (tr-auth)

53079 EXCLUDED POSSIBILITIES OF GEOMETRODYNAMICAL ANALOG TO ELECTRIC CHARGE. Unruk, W. G. (Princeton Univ., N. J.). Gen. Relativity Gravitation; 2: No. 1, 27-33 (1971).

Reference is made to previous work where it was shown that the existence of charges need not be associated with sources in the electromagnetic field equations, but could be described as a consequence of Maxwell's free field equations in a space with a multiply connected topology. The lines of electric force can be "trapped" in the topological structure of space, with the number of trapped lines directly proportional to the charge associated with the field. In order to make this idea clearer consideration is given to a simple example of a multiply connected or "wormhole" topology trapping the lines of force. If the interiors of two solid spheres of equal radius are removed from an ordinary three-dimensional Euclidean space, and the appropriate points on the surfaces of the two spheres are identified, a "wormhole" in space is obtained. These concepts are put into rigorous mathematical form. The question of what is meant by a geometrical analog to electric charge is discussed, and excluded possibilities are determined. (UK)

53080 MAGNETIC CHARGE, HOLONOMY, AND CHARACTERISTIC CLASSES: ILLUSTRATIONS OF THE METHODS OF TOPOLOGY IN RELATIVITY. Clarke, C. J. S. (Cambridge Univ., Eng.). Gen. Relativity Gravitation; 2: No. 1, 43-51 (1971).

It is stated that peculiarities in the topology of space-time are no longer seen as minor complications arising from a symmetrical model, but as interesting physical variables in their own right, forming an integral part of the description of the universe; in this situation the relativist may well consider applying the methods of algebraic topology. These methods are illustrated in exploring some aspects of the topological structure of the bundles that are used in general relativity. It is suggested that many properties of elementary particles can be defined in a topological manner. The view of Wheeler, in connection with previous work that there is little hope of obtaining from geometry any kind of charge, is endorsed. The electromagnetic field was previously considered as a means of defining real cohomology classes that could be interpreted as charges; a slightly different standpoint is taken, and potential is used instead of field to examine magnetic charge. This is then generalized in an attempt to find cohomology classes that can be associated with particles, but which are not conserved in interactions. By working with integral, rather than real cohomology, the results will automatically have a discrete spectrum. (UK)

53081 PHOTON–PHOTON SCATTERING INTO HADRONS FROM FINITE-ENERGY SUM RULES. Bramon, A.; Greco, M. (CNEN, Frascati, Italy). Lett. Nuovo Cim.; 2: No. 10, 522-6 (4 Sep 1971).

The contribution from the $J^P = 0^-$, 0^+, and 2^+ states to the total cross section for hadron production in photon–photon interactions is evaluated, using duality and finite-energy seem rules to evaluate the coupling of the two-photon system to a scalar or tensor meson. Adding together the different contributions, it is found that the predicted rate for hadron production by two-photon mechanism exceeds 10^{-32} cm^2 at E = 1.5 GeV and is, therefore, comparable with the e^+e^- annihilation cross sections. (L.B.S.)

53082 COVARIANT EQUATIONS FOR THE COVARIANT SPIN 3-VECTOR. Ringhofer, K. (Univ., Munich). Acta Phys. Austr.; 32: No. 1, 78-86(1970).

The classical spin four-vector S^μ as introduced previously is perpendicular to the four-velocity u^μ. Therefore, it is tangent to the "velocity-hyperboloid" $u^2 = -1$ and can be described either by a contravariant 3-vector S^i or by a covariant 3-vector S_i. Up to a velocity-dependent factor, S_i agrees with a spin 3-vector already proposed. It is of advantage to consider S_i as the component of the spin in the direction $e^{(i)}$ of the Euclidean 3-space. With this definition, in a homogeneous magnetic field the spin 3-vector moves nearly exact as in the nonrelativistic case even in the presence of an anomalous moment of the particle. Furthermore, a Stern–Gerlach experiment designed to produce particles polarized in direction $e^{(i)}$ would just yield particles with $S_k = 0$ for $k \neq i$. To get covariant equations of motion for the spin 3-vector, it is necessary to introduce a covariant time-derivative. The previous equations for the motion of the spin-four vector (and their generalizations to inhomogeneous fields) can then be written as covariant equations for the spin three-vector and allow an immediate physical interpretation. Besides they allow elegant and easy methods to find the solutions of the equations of motion. This is demonstrated for the case of a general homogeneous field. (auth)

53083 ELECTRON–POSITRON PAIR FORMATION BY PHOTONS IN THE FIELD OF AN ELECTROMAGNETIC WAVE IN AN HOMOGENEOUS MAGNETIC FIELD. Oleinik, V. P. (Inst. of Semiconductors, Kiev). Zh. Eksp. Teor. Fiz.; 61: No. 1, 27-44(Jul 1971). (In Russian).

It is shown that due to the appearance of new bands in the quasienergy spectrum of an electron interacting with a classical electromagnetic wave and homogeneous magnetic field, the production of an electron-positron pairs in the field is possible for $\omega' \ll +2m$ (ω' is the frequency of the photon producing the pair and m is the electron mass) in the absence of real absorption of external field quanta. Modification of the quasienergy spectrum of an electron in an external field is analogous to the Lamb level shift in the hydrogen atom. It is a consequence of virtual multi-quantum processes involving absorption of a certain number of external field quanta by the electron and simultaneous return of the same number of quanta to the field. The pair production probability is calculated for two cases corresponding to two different mechanisms of pair production. In one case pairs are formed as a result of true absorption of such a number of quanta from the electromagnetic wave which are sufficient for overcoming the energy barrier between the electron and positron states. In the second case pair formation occurs as a result of appearance of new bands in the electron quasienergy spectrum. (auth)

53084 ELECTROMAGNETIC RADIATION PRESSURE ON FREE ELECTRONS. Levich, E. V. (Inst. of Chemical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 1, 112-17(Jul 1971). (In Russian).

The pressure of electromagnetic radiation on free electrons in the spectral field of the radiation is calculated. It is shown that the pressure force acting on an electron in the spectral field of radiation essentially differs from that in the field of a plane electromagnetic wave. (auth)

53085 ESTIMATES OF INTENSITY OF RADIATION EMITTED BY A MODULATED ELECTRON BEAM. Zel'dovich, B. Ya. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 61: No. 1, 135-8(Jul 1971). (In Russian).

The intensity of radiation emitted by an electron beam modulated with a frequency of light is estimated. It is shown that the theoretical models of such radiation proposed recently to explain the Schwarz and Hora experiments are not consistent with the results obtained. (auth)

53086 RESONANT PRODUCTION OF VECTOR MESONS BY POLARIZED PHOTONS. SPECIAL CONSIDERATIONS ON THE ρN DECAY MODE OF Δ(1950) AND Δ(2420). Schildknecht, D. (DESY, Hamburg); Schrempp-Otto, B. Nuovo Cim., 5A: 103-37 (1 Sep 1971).

The differential cross section and the vector-meson density-matrix elements for resonant production of vector mesons from nucleons $\gamma N \rightarrow \text{resonance}^J \rightarrow VN$ are given in terms of partial-wave helicity and multipole amplitudes. A large-J approximation of the $d^J(\theta)$ functions turns out to yield a good qualitative picture of the behavior of the differential cross section and density-matrix elements for $J \gtrsim 11/2$. Numerical results for the differential cross section for $\gamma N \rightarrow \Delta^J \rightarrow \rho N$ and for the ρ density-matrix elements are presented for the special model of magnetic excitation and decay, which is motivated from quark-model and vector-meson–dominance model considerations. The observability of these resonance formation processes with unpolarized and polarized photons is extensively discussed by taking into account the diffractive background present in ρ^0 production from protons. Much of the material of this work may also be used to discuss resonance effects in Compton scattering. (auth)

53087 PERIODIC SOLUTIONS OF A NONLINEAR DIFFERENTIAL EQUATION. Bradbury, Ted Clay; Brintzenhoff, Alton (California State Coll., Los Angeles). J. Math. Phys. (N. Y.); 12: No. 7, 1269-75(Jul 1971).

Periodic solutions of the nonlinear differential equation $\ddot{x} + f(x) = 0$ are investigated. The qualitative characteristics of the solution are explored and several theorems about the basic nature of the solution are presented. The solution is then obtained in terms of a Fourier series and numerical calculations are carried out to fifth-order accuracy. The dependence of the frequency of the solution on the amplitude is studied. As an example, the solution is applied to the problem of obtaining the orbit of a charged particle moving in a radial electric field. (auth)

53088 ANALYSIS OF SINGLE PHOTOPRODUCTION ON NEUTRONS IN THE SECOND-RESONANCE REGION. Proia, A.; Sebastiani, F. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Lett. Nuovo Cim.; 2: No. 11, 560-4(11 Sep 1971).

An analysis was made of Frascati spark chamber and bubble chamber data on π^- and π^0 photoproduction on neutrons at 540 to 830 MeV based on an isobar model. Best fit results for the multipole amplitudes and for the total cross sections, differential cross sections, and polarizations are presented. The results of the analyses show a great contribution to the photoproduction on neutrons of the resonant states P_{11} and S_{11}, while the resonant contributions of the D_{13} are a little less considerable. (L.B.S.)

53089 CLASSICAL ELECTRON, A MODEL FOR AN EXTENDED CHARGED PARTICLE. II. INCLUSION OF GRAVITATIONAL EFFECTS IN GENERAL RELATIVITY. Katz, J.; Horwitz, G. (Hebrew Univ., Jerusalem). Nuovo Cim.; 5B: No. 1, 59-69(11 Sep 1971).

The general-relativistic version of a classical model of an extended electron was worked out. The main interesting properties of the special-relativistic version are formally maintained in general relativity. Small corrections to the mass and radius of the particle due to gravitational effects were calculated to first order. (auth)

53090 GEODESICS OF AN AFFINE CONNECTION AND ELECTROMAGNETISM WITH RADIATION REACTION. Burman, R. R. Bull. Aust. Math. Soc.; 4: No. 2, 225-40(1971).

The motion of a point test charge in an external electromagnetic field with the effect of electromagnetic radiation reaction included is considered. The equation of motion applicable in a general Riemannian space-time is written as the geodesic equation of an affine connection. The connection is the sum of the Christoffel connection and a tensor which depends on, among other things, the external electromagnetic field, the charge and mass of the particle and the Ricci tensor. The affinity is not unique; a choice is made so that the covariant derivative of the metric tensor with respect to the connection vanishes. The special cases of conformally flat spaces and the space of general relativity are discussed. (auth)

53091 PHOTOPRODUCTION OF VECTOR MESONS IN THE IMPULSE APPROXIMATION. Rumyantsev, V. S. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 5, 123-6(1970). (In Russian).

A model for the elastic scattering of ρ^0 mesons on protons is proposed. A comparison with experiment is given on the basis of the vector dominance hypothesis, which permits the calculated differential cross section for elastic scattering of ρ^0 mesons on protons to be related with the differential cross sections for photoproduction of ρ^0 mesons on protons $d\sigma_{\gamma p}/dt$. In the frame of the impulse approximation $d\sigma_{\rho^0 p}/dt$ is expressed in terms of the differential cross sections of the elastic scattering of π mesons on protons. Satisfactory agreement between theoretical estimates and experiment indicates that the proposed mechanism of scattering can play an important role in the photoproduction of ρ^0 mesons in the range $-t \geq 0.2(\text{GeV}/c)^2$. (tr-auth)

53092 PARTICLE WITH VARIABLE SPIN $1/2$ TO $3/2$ IN THE FIELD OF A PLANE ELECTROMAGNETIC WAVE. Lobko, S. I.; Fedorov, F. I. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 5, 76-81(1970). (In Russian).

On the basis of a general method for finding an accurate solution for the problem concerning an arbitrary-spin particle in the field of a flat electromagnetic wave, the solution of an equation for a particle with variable spin $1/2$ to $3/2$ and with two rest masses m and m/λ in the field of a plane electromagnetic wave were found. (tr-auth)

53093 ASYMPTOTICAL BEHAVIOUR OF THE TOTAL γp- AND $\gamma\gamma$-CROSS SECTIONS OFF THE MASS SHELL. Efremov, A. V.; Ginzburg, I. F. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 36B: No. 4, 371-4(20 Sep 1971).

It is shown that the Regge type behavior and the scaling law $S\sigma_{\gamma p_2} \sim f(-S/q_2)$ give for $S\sigma_{\gamma\gamma}$ the asymptotics $f(SS_0/q_1^2 q_2^2)$ at large S, q_1^2 and q_2^2. This result is confirmed by the summation of the diagrams in φ^3-theory. It is announced also that the introduction of the spin (γ^5-theory) results in a slight breaking of the scaling law and in the suppression of the scalar photon contribution to these processes compared with the contribution of the transversal photon. (auth)

53094 DOUBLE DISPERSION RELATIONS FOR THE AMPLITUDE OF THE DEUTERON COMPTON EFFECT. Maksimenko, N. V.; Moroz, L. G. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 5, 88-93(1970). (In Russian).

Double Mandelstam dispersion relations were constructed for each of 12 independent amplitudes for the Compton effect on a deuteron. (tr-auth)

53095 MESON MASS FORMULA IN NONET SCHEME. Okubo, Seiji (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto); 45: No. 6, 2004-6(Jun 1971).

A mass formula is considered in the nonet scheme to obtain information on a singlet meson mass. The mass relations are compared with experiment for the 0^--meson nonet. (L.B.S.)

53096 DIFFRACTIVE INELASTIC PROCESSES AT EXTREMELY HIGH ENERGIES. Cheng, H. (Massachusetts Inst. of Tech., Cambridge); Wu, T. T. Phys. Lett.; 36B: No. 4, 357-60(20 Sep 1971).

At infinite energy, it is predicted that for all diffractive processes, initiated by either hadrons or photons, the integrated cross section approaches infinity and dips appear in the angular distribution. Results for pionization are also given and the theoretical basis is discussed. (auth)

53097 WHY IS ρ' PHOTOPRODUCTION SUPPRESSED? Frampton, P. H.; Schilling, K.; Schmid, C. (CERN, Geneva). Phys. Lett.; 36B: No. 4, 361-6(20 Sep 1971).

The experimentally observed ρ and ρ' photoproduction cross sections can be explained in terms of a multiperipheral production mechanism and duality. The small value for the ratio of the Pomeron (P) couplings $g_{\gamma P\rho'} : g_{\gamma P\rho}$ has no application for the ratio $g_{\gamma\rho'} : g_{\gamma\rho}$. (auth)

53098 DEEP INELASTIC e-p SCATTERING IN A VENEZIANO-LIKE MODEL INCLUDING DIFFRACTION. Atkinson, D. (Univ., Bonn); Contogouris, A. P. Nucl. Phys.; B31: No. 2, 429-42(1971).

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The Veneziano-inspired approach to deep inelastic e-p scattering is extended to include pomeron-dominated (diffractive) contributions. A four-point amplitude is presented in which the Pomeranchuk singularity, $\alpha_P(t)$, is dual to a background contribution in s. This background is characteristic of a Regge-cut, as seen in the large $|t|$ asymptotics. When the amplitude is extended to virtual photon-nucleon scattering, it scales in the Bjorken limit. When it is combined with the dual, non-diffractive amplitude of Landshoff and Polkinghorne, it accounts well for the proton inelastic form factor in the whole scaling region, and leads to a total ρN cross-section in order-of-magnitude agreement with experiment. (auth)

53099 POLARISATION EFFECTS IN THE NON-PERTURBATIVE PARTON MODEL OF DEEP INELASTIC SCATTERING. Nash, C. (Cambridge Univ., Eng.). Nucl. Phys.; B31: No. 2, 419-28(1971).

The effect of polarization is studied in deep inelastic scattering. Scaling properties are established and sum rules and other relations following from the quark parton model evaluated. (auth)

Weak

Refer also to abstract 53522.

53100 (NYO-4204-14) COMMENTS ON HADRONIC CONSERVATION IN INELASTIC LEPTON–NUCLEON REACTIONS. Elitzur, M.; Pais, A. (Rockefeller Univ., New York). [1971]. Contract AT(30-1)-4204. 8p. Dep. NTIS.

If and where inelastic lepton-nucleon reactions satisfy hadronic helicity conservation in an arbitrary hadronic frame, isotropy is shown to follow with respect to an azimuthal angle, properly defined. For all instances other than s-channel helicity conservation, another dynamical variable must be made to vary in order to observe this azimuthal independence at a given incoming laboratory energy of the leptons. The discrimination between different hadronic frames with regard to possible helicity conservation demands some care, since such conservation can lead to approximately the same isotropy effect in certain specified kinematic regions. (auth)

53101 (NYO-4204-18) COMMENT ON A RIGOROUS BOUND FOR THE $f_+(o)$ FORM FACTOR OF K_{l3} DECAY. Li, Ling-Fong; Pagels, Heinz (Rockefeller Univ., New York). [1971]. Contract AT(30-1)-4204. 4p. Dep. NTIS.

A rigorous bound on the form factor $f_+(o)$ in the form $|f_+(o)| \le [16/(m_K - m_\pi)(\sqrt{m_K} + \sqrt{m_\pi})]\ [\pi\Delta(0)/3(m_K + m_\pi)]^{1/2}$, where $\Delta(o)$ is the propagator of the divergence of the strangeness changing current at zero momentum transfer, is derived. Using a previous estimate for $\Delta(o)$, $|f_+(o)| \le 1.0$ and $|f_K/f_\pi| \le 1.28$ are obtained. (auth)

53102 (UCRL-20655, pp 203-19) WORKSHOP TALK ON WEAK INTERACTIONS. Wolfenstein, L. Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

The discussion of weak interactions deals with tests of the Cabibbo theory, second-class currents, CP and T violation, and forbidden decays. A list is given of thirty major experimental results in weak interaction physics from 1957 to 1969. Some major experiments for the next decade are also listed. (L.B.S.)

53103 SPIN-ZERO POLE DOMINANCE IN THE WEAK AND ELECTROMAGNETIC INTERACTIONS OF THE K-MESON. Arnowitt, R.; Friedman, M. H.; Nath, P.; Pond, P. (Northeastern Univ., Boston). Nuovo Cim.; 4A: No. 4, 765-72(21 Aug 1971).

The assumption of π, η and σ dominance of the weak and electromagnetic decays of the K-meson is examined using the hard-meson current algebra amplitudes for the strong-interaction factors. The $K \rightarrow 3\pi$ decay spectrum, the $K_L^0 \rightarrow 2\gamma$ decay and the $K_L^0 - K_S^0$ mass difference are calculated and compared with experiment. (auth)

53104 VECTOR RENORMALIZATION IN K_{l3} DECAY, THE CONTRIBUTION OF THE AXIAL VECTOR MESONS. Nasrallah, N. F. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). Nuovo Cim.; 4A: No. 4, 845-50(21 Aug 1971).

The contribution of the $K_A(1240, J^P = 1^+)$ to the renormalization of the K_{l3} form factor $f_+(0)$ is estimated. $f_+(0) = 0.94$ is obtained. (auth)

53105 MODEL FOR K_{l3} FORM FACTORS AND CABIBBO ANGLE. Yamada, M. (Univ. of Texas, Austin). Nuovo Cim.; 4A: No. 4, 866-72(21 Aug 1971).

A quark model of K_{l3} form factors is discussed using Regge-pole theory. It is shown that $\xi(t) = f_-(t)/f_+(t)$ for $0 < t < 7\mu_\pi^2$ can be fitted and that there is a dip in $f(t) = f_+(t) + tf_-(t)/\mu_K^2 - \mu_\pi^2$. Within the same model, the Cabibbo angle is also calculated to be 0.26, assuming that the SU_3 breaking is significant for masses in a multiplet but not for the strong couplings. (auth)

53106 COMMENTS ON LEPTON-INDUCED HADRON PROCESSES AT HIGH ENERGY. Bjorken, J. D. (Stanford Univ., Calif.). pp 217-29 of Eighth Annual Eastern Theoretical Physics Conference Proceedings. /Rohrlich, F. (ed.). Syracuse, N. Y.; Syracuse Univ. (1969).

From eighth eastern theoretical physics conference; Syracuse, N. Y. (10 Oct 1969). See CONF-691033.

The data on electroproduction and neutrino interactions is briefly reviewed, and the relations of these data from the conserved vector current hypothesis are considered. The relation between these processes and equal-time current commutators is discussed, and also the space-time structure of the current commutator is covered. (J.F.P.)

53107 PRODUCTION CROSS SECTION OF LEE–WICK HYPOTHETICAL MASSIVE ELECTROMAGNETIC BOSONS BY MUONS AT HIGH ENERGIES. Linsker, Ralph (Goddard Space Flight Center, New York. Columbia Univ., New York). Phys. Rev. Lett.; 27: No. 3, 167-70(19 Jul 1971).

The total cross section is computed for the resonant process $\mu^\pm + Z \rightarrow \mu^\pm + Z + B^0 \rightarrow \mu^\pm + Z +$ (hadrons or leptons), where B^0 is the hypothetical massive spin-1 boson of electromagnetic interactions, proposed by Lee and Wick, and where Z is either a proton or Fe. Only those diagrams in which the B^0 is emitted by the muon are calculated. (auth)

53108 BEHAVIOR OF SPACE COMPONENTS OF CURRENTS UNDER SU(3) $\otimes$ SU(3) TRANSFORMATIONS. Katz, J.; Ram Mohan, L. R. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 4: No. 2, 415-25(15 Jul 1971).

It is suggested that the equal-time commutators between the axial charges and the space components of the currents should be modified. A model is presented which provides a natural explanation for the value $\xi = -1$ for the ratio of form factors in K_{l3} decays and, in addition, leads to the usual good results of current algebra. (auth)

53109 COMMENT ON DECAYS OF HEAVY CHARGED LEPTONS. Beier, E. W. (Univ. of Pennsylvania, Philadelphia). Lett. Nuovo Cim.; 1: No. 26, 1118-20(26 Jun 1971).

The decays of charged heavy leptons which interact through V-A coupling with strength $G/\sqrt{2}$ and are associated with a distinct neutrino ν_L are considered. It is pointed out that for certain lepton masses, the decay $L^- \rightarrow \pi^-\pi^0\nu_L$ is an important decay mode; its absolute partial decay rate tests the conserved-vector-current hypothesis at large timelike momentum transfers. Partial decay rates for $L^- \rightarrow \pi^-\pi^0\nu_L$, $L^- \rightarrow \pi^-\nu_L$, $L^- \rightarrow e^-\bar{\nu}_e\nu_L$, and $L^- \rightarrow \mu^-\bar{\nu}_\mu\nu_L$ are presented. (L.B.S.)

53110 $\Delta I = 1/2$ RULE IN P-WAVE NONLEPTONIC HYPERON DECAYS. Reid, J. H.; Trofimenkoff, N. N. (Univ. of Calgary, Alberta). Lett. Nuovo Cim.; 1: No. 26, 1121-3(26 Jun 1971).

It is demonstrated that for Λ and Σ decays, where the final-state scattering phase shifts are known to a high energy, $\Delta I = 1/2$ sum rules for the P-wave amplitudes can be obtained through final-state interactions. (L.B.S.)

53111 $|\Delta T| = 1/2$ RULE IN $K \rightarrow 2\pi$, 3π DECAYS AS CONSEQUENCE OF A DYNAMICAL SYMMETRY. Kapustnikov, A. A. (Dnepropetrovsk State Univ., USSR). Yadern. Fiz.; 13: No. 6, 1296-1300(Jun 1971). (In Russian).

It is shown that in the Lagrangian model without derivatives the $|\Delta T| = 1/2$ rule in the $K \rightarrow 2\pi$, 3π decays is a consequence of the dynamical $SU_R(2)$ symmetry of the nonleptonic weak interactions. (auth)

53112 $\mu \rightarrow e + \nu + \bar{\nu}$ DECAY AND RESTRICTIONS ON THE MASS OF NEUTRINO, W BOSON, AND WEAK INTERACTION VARIANTS. Rekalo, A. P. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 13: No. 6, 1288-95(Jun 1971). (In Russian).

The $\mu \rightarrow e + \nu + \bar{\nu}$ decay is considered in the framework of the weak interactions transferred by a charged vector boson. The constants of the axial-vector interaction in the muonic and electronic vertices are different and do not coincide with the weak interaction constant. For the spectra of electrons produced in $\mu \rightarrow e + \nu + \bar{\nu}$ decay, general expression is obtained with the account of $m_{\nu_\mu} \neq 0$, with the help of which the formula for the spectrum parameters in terms of m_{ν_μ}, m_W, and the values of deviation of the weak interaction variant from V – A, are obtained. Using the experimental values of the electron spectrum parameters, the restrictions on the masses of neutrino, W boson and on the value of deviation of the interaction from the V – A variant are obtained. (auth)

53113 ABSENCE OF A FORM FACTOR IN THE e^2 CORRECTIONS TO THE NEUTRINO–ELECTRON AND NEUTRINO–

PROTON SCATTERING AMPLITUDES. Ioffe, B. L.; Sokolov, V. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: No. 6, 1279-83(Jun 1971). (In Russian).

Assuming that the imaginary part of the virtual photon-nucleon (or the W-boson-nucleon) scattering amplitude does not depend on the momentum transfer t at $|g^2| \gg |t|$, where q is the photon momentum, the e^2 correction is calculated to the amplitude of the process $\nu + N \rightarrow l + N$ due to the photon exchange between the hadrons and the lepton. It is shown that the correction has no nucleon form factor at large t. (auth)

53114 DISCRETE SCALE TRANSFORMATIONS AND A POSSIBLE LEPTON MASS SPECTRUM. Tennakone, Kirthi; Pakvasa, Sandip (Univ. of Hawaii, Honolulu). Phys. Rev. Lett.; 27: No. 11, 757-60(13 Sep 1971).

A partial solution to the muon puzzle is offered. Discrete scale transformations are used to derive a mass spectrum for leptons which includes all the observed leptons. The difference between the electron and muonlike particles is demonstrated explicitly. Experimental tests of the theory are discussed including the detection of the predicted 22-GeV electron. (auth)

53115 SPIN-0 KEMMER WAVE FUNCTIONS AND K_{13} FORM FACTORS. Nagel, Bengt; Snellman, Haekan (Royal Inst. of Tech., Stockholm). Phys. Rev. Lett.; 27: No. 11, 761(13 Sep 1971).

The recent assertion stating the nonequivalence of the Kemmer and the Klein-Gordon spin-0 wave functions in the analysis of K_{13} decays is shown to be incorrect. (auth)

53116 SECOND-CLASS CURRENTS AND THE $\mu-e$ RATIO FOR SEMI-LEPTONIC HYPERON DECAYS. Jaeger, W.; Rupertsberger, H. W. (Univ., Vienna). Lett. Nuovo Cim.; 2: No. 8, 421-3(21 Aug 1971).

It was recently suggested that a second-class current might be introduced by the divergence of an appropriate tensor density which is added to the usual hadronic current of weak interactions. The effects of this current in the calculation of the $\mu-e$ ratio for the general $|\Delta Y| = 1$ decay $\Delta \rightarrow B + l^- + \bar{\nu}_l$ are examined. (L.B.S.)

53117 K-MESON DECAY AND ADDITIONAL STRANGE-0^--MESON TRAJECTORY DERIVED FROM THE REQUIREMENT OF DUALITY. Minami, S. (Osaka City Univ.). Lett. Nuovo Cim.; 2: No. 7, 342-4(14 Aug 1971).

As a possible degeneracy pattern for the $\dot{K}$ and K_β trajectories, in addition to the exchange-degenerate $K-K_\alpha$ trajectories, the following case is considered: the K(495) lies on both the K_α and K_β trajectories; then it is difficult to discriminate between the strange 0^- mesons with M = 495 MeV belonging to the K and $\dot{K}$ trajectories, because they have the same quantum numbers. For this case the description of the characteristic properties of K-meson decay is examined. It is pointed out that the existence of the $\dot{K}$ trajectory might explain the abnormal $K_2 \rightarrow 2\pi$ decay mode without any violation of CP invariance. (L.B.S.)

53118 VERTEX FUNCTION IN THE THEORY OF LEPTON WEAK INTERACTION. Getmanov, B. S.; Filippov, A. T. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 8: No. 1, 3-15(Jul 1971). (In Russian).

A vertex function in the Edwards approximation is considered in the V-A theory of weak interaction between leptons and W bosons. Linear integral equations for the sum of the ladder type diagrams (Edwards equations) are reduced to a boundary-value problem for a system of linear differential equations. The existence of a unique solution of this problem is proved and the higher-order corrections are estimated. The leading correction to the renormalized vertex function is found to be of the order $g^2 \ln g^2$. The dispersion sum rules are used to prove the existence theorem. The new "Euclidean momenta sum rules" for the vertex function are derived. (auth)

53119 THEORETICAL IMPLICATION OF ξ, THE RATIO OF f_- TO f_+ FORM FACTOR IN K_{13} DECAY, EQUAL TO MINUS ONE. Deshpande, N. G. (Northwestern Univ., Evanston, Ill.). Lett. Nuovo Cim.; 2: No. 10, 507-10(4 Sep 1971).

It is shown by a simple analysis that, if $\xi = -1$, the matrix element of the divergence of the vector current between a state of K-meson and π-meson has a zero in the momentum transfer at about the K-meson mass. An alternative explanation is presented, and the implications for the k-meson and k_{13} decay are discussed. (L.B.S.)

53120 THEORY OF μ^+-MESON DEPOLARIZATION IN WHICH CHARGE EXCHANGE AND FORMATION OF UNSTABLE CHEMICAL COMPOUNDS ARE TAKEN INTO ACCOUNT. Ivanter, I. G.; Smilga, V. P. Zh. Eksp. Teor. Fiz.; 60: No. 6, 1985-2000(Jun 1971). (In Russian).

A consistent theory of μ^+-meson depolarization in magnetic fields parallel to the direction of initial μ^+-meson polarization is developed in which the possibility of charge exchange occurring is taken into account. Formulas for residual polarization and dependence of polarization on time are derived. An analysis of the formulas shows that in some cases experiments in longitudinal fields should be sufficient to detect charge exchange processes. The results obtained expand the class of substances which can be investigated by means of the μ^+-meson technique. The theory can primarily be used for investigation of semiconductors. The formalism developed also describes a different physical situation when there are two competing chemical reaction channels for the μ^+-meson, one of them leading to the formation of an unstable diamagnetic chemical compound. (auth)

53121 $\Delta I = 1/2$ RULE, $S(\Sigma^+_+) = 0$, $P(\Sigma^-_-) = 0$ AND LAW OF CONFIGURATION CONSERVATION IN WEAK NONLEPTONIC PROCESSES. Nakagawa, Masami (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1990-2(Jun 1971).

A rule for configuration conservation in weak nonleptonic processes previously derived by Ikeda, Miyachi, and Ogawa is generalized to fit both the parity-conserving and parity-violating transitions of the hyperon decays. The generalized rule is shown to predict new sum rules for Ω^- decays. (L.B.S.)

53122 DECAY $K_{L^0} \rightarrow 2\pi$ IN A DEGENERATE NEUTRINO SEA. Yokoo, Yoshimatsu (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 6, 2000-1(Jun 1971).

The effect that occurs in the 2π decay of neutral K mesons if the neutrino sea exists is discussed. The mass, decay modes, and CP violating parameters are discussed. (L.B.S.)

53123 η- AND K-3π DECAYS WITH ONE CURRENT IN DUAL THEORY. Miyatake, Yoshio (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 6, 2006-8(Jun 1971).

It is shown that, if the one-current formalism is used instead of two-current formalism and if the local state is used as the initial state, the $\eta \rightarrow 3\pi$ or $K \rightarrow 3\pi$ decay processes can be formulated in the complete Veneziano-type formalism instead of connecting the weak or electromagnetic part with the Veneziano part as in the usual formalism. (L.B.S.)

53124 CHARACTERISTIC FEATURES IN NONLEPTONIC HYPERON DECAYS AND COMPOSITE MODELS. Katuya, Mituaki (Hokkaido Univ., Sapporo); Fujii, Kanki; Okubo, Seiji; Murayama, Akihiro. Progr. Theor. Phys. (Kyoto); 45: No. 6, 1944-54(Jun 1971).

The necessary conditions in the SU(3) frame imposed on nonleptonic hyperon decay amplitudes by studying various selection rules are summarized and relations between connected-urbaryon-diagrams and physical decay amplitudes are discussed. On the basis of a nonrelativistic weak skeleton model, the 3*-model is introduced and its consequences are discussed. (auth)

53125 CHIRAL LAGRANGIANS, SU(3) × SU(3) FIELD ALGEBRA, SYMMETRY BREAKING AND K_{14} DECAY. Wood, L. E. (Washington Univ., St. Louis); Mitter, P. K.; Swank, L. J. Nucl. Phys.; B31: No. 2, 205-21(1971).

The self-consistent method of implementing chiral symmetry and symmetry breaking assumptions through phenomenological Lagrangian techniques is studied. The basic assumptions are octet PCAC and PCVC through $(3^*,3) + (3,3^*)$ symmetry breaking, field algebra (and field-current identity) and smooth momentum dependence. These assumptions give hard pion results and a smooth extrapolation to the soft pion PCAC results. In general this may be applied to n-point functions. The main applications in this paper will be to the three and four point functions which contribute to the form factors of K_{13} and K_{14} decays. Strong decay rates of spin one resonances are used to determine unknown constants in these form factors. The results for the usual K_{13} parameters are $\lambda_+ = 0.024$ (0.022), $\lambda_- = 0.024$ (0.027) and $\xi = -0.27$ (-0.23) for a K_A mass of 1230 (1320) MeV. The new hard pion results from these assumptions give significant corrections to the soft pion results. The hard pion form factors are momentum dependent and contain some unknown parameters not determined by the general assumptions; explicit expressions for the axial vector K_{14} form factors are given. (auth)

53126 NEUTRINOPRODUCTION OF PIONS NEAR THE FIRST RESONANCE. Roehner, B.; Cochard, G.; Karatchentzeff, M.; Kessler, P. (College de France, Paris). Nucl. Phys.; B31: No. 2, 349-59(1971).

Inelastic scattering of neutrinos in the region of the N*(1236) resonance was calculated, using a model of the type "isobar plus Born terms." Applying CVC and PCAC in a strict way, no free parameter was left. In the analytic calculation, the generalized helicity method was used, in order to separate the various polarization terms in the cross section. Numerical results are shown separately for the vector part, the axial part and the vector-axial interference in both the Born term contribution and the isobar contribution. Finally, a comparison is made with experimental data obtained at CERN. (auth)

53127 TIME DEPENDENCE OF THE MUON POLARIZATION VECTOR AND THE $\Delta S = \Delta Q$ RULE IN $K^0_{\mu 3}$ DECAY. Ebrahim, Abdul (Yale Univ., New Haven). Nucl. Phys.; B31: No. 2, 269-77(1971).

The time dependence of the muon polarization vector in $K^0_{\mu 3}$ decay is calculated under the assumption that the $\Delta S = \Delta Q$ rule is violated. The initial beam is taken to be an arbitrary superposition of K^0_L and K^0_S states. Four form factors, $f_\pm$ for the $\Delta S = \Delta Q$ amplitude and $g_\pm$ for the $\Delta S = -\Delta Q$ amplitude, enter into the description of the decay. It is shown that when $f_\pm$ and $g_\pm$ are not proportional, all three orthogonal components of the polarization vector are non-vanishing and time dependent, even when there is no T violation in the decay. The possibility of experimentally observing this time dependence of the polarization vector is examined for the case where the initial beam is a pure K^0 beam. It is found that the present experimental limits on $f_\pm$ and $g_\pm$ allow a time variation of all components of the polarization vector of the order of 10–20%. If such a time dependence of the components of the polarization vector can be measured experimentally. It would provide an alternative test for the $\Delta S = \Delta Q$ rule in $K^0_{\mu 3}$ decay. (auth)

53128 CHIRAL ALGEBRA OF FIELDS AND SEMI-LEPTONIC WEAK INTERACTIONS. Gottlieb, H. P. W. (Cambridge Univ., Eng.). Nucl. Phys.; B31: No. 2, 400-18(1971).

The field algebra model with symmetry breaking which has been introduced in a previous paper is generalized to include axial-vector mesons and pseudoscalar mesons forming a nonlinear realization of chiral SU(3) × SU(3). It is used in the Cabibbo theory of weak processes to obtain the form factors for K_{l3} and baryon semi-leptonic decays. Sum rules for the latter in the presence of symmetry breaking are verified. (auth)

Strong (General)

53129 (NYO–4204-15) GRADIENT TERMS IN SCALAR DENSITY-CHARGE DENSITY COMMUTATOR. Zepeda, A. (Rockefeller Univ., New York). [1971]. Contract AT(30-1)-4204. 22p. Dep. NTIS.

In a previous perturbative model, the one meson to vacuum matrix element of the equal time commutator of the charge density of a vector current and a scalar density is computed. A gradient term is found. Consequences of this result for the dimensionality of the current components are discussed. (auth)

53130 (UCRL–20655, pp 129-68) SPECTRUM OF LOW-LYING HADRON STATES. Rosner, Jonathan L. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

The low-lying meson and baryon states are reviewed from various theoretical standpoints, with particular emphasis on the quark model scheme of classification. Experiments to fill in gaps are suggested where possible. (auth)

53131 (UCRL–20655, pp 277-340) MULTIPARTICLE REACTIONS AT INTERMEDIATE ENERGIES. Quigg, C. (State Univ. of New York, Stony Brook. Inst. for Theoretical Physics). Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

Recently developed concepts and models which can be used to study multiparticle production in hadron collisions are reviewed. The need to draw upon experience and intuition gained from quasi two-body collisions is emphasized, and some simple ways to make use of two-body data are suggested. A theoretical framework based upon an optical theorem analogue is described, which permits the application of the accumulated wisdom of two-body Regge phenomenology to the study of inclusive reactions. The new Regge phenomenology leads to many predictions which may be tested at energies below 20 GeV. Valuable studies which take advantage of existing data are outlined, together with some new experiments to illuminate the physics of production reactions. Brief summary remarks are made about the outlook for medium-energy studies of inclusive reactions in the immediate future. (auth)

53132 (UCRL–20655, pp 341-95) INTERMEDIATE ENERGY EXPERIMENTS ON QUASI-TWO-BODY PRODUCTION. Diebold, R. (Argonne National Lab., Ill.). Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

Several types of experiments giving useful information on production mechanisms at intermediate energies are discussed. The various experiments are grouped according to the experimental methods: these include missing-mass and two-arm spectrometers; effective mass spectrometers; many-particle experiments; experiments in external proton beams; polarized targets; and deuterium targets. (L.B.S.)

53133 (UCRL–20655, pp 453b-5) SOME USEFUL HADRONIC EXPERIMENTS AT INTERMEDIATE ENERGIES. Berger, E. L.; Fox, G. C.; Quigg, C.; Ringlund, G. A. Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

Broad classes of experiments and some specific interactions at intermediate energies are outlined; these include stable particle channels in the phase shift region, multiparticle channels in the phase shift region, bubble chamber program, high-energy counter experiments, and high statistics experiments above 3.0 GeV/c. (L.B.S.)

53134 INTER-RELATION OF THE HIGH ENERGY REGION AND THE LOW ENERGY REGION. Michael, C. (European Organization for Nuclear Research, Geneva). pp II82-93 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

The recent status of high energy models is briefly discussed. Some evidence for duality and its main consequence, exchange degeneracy, is presented. Finally, models for breaking exchange degeneracy are discussed. (France)

53135 REGGE CUTS IN ELASTIC REACTIONS. Capella, A. (Paris Univ., Orsay, France). pp III56-73 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

Some difficulties of the simple Regge pole model are reviewed; they seem to indicate that other singularities, such as Regge cuts for instance, are present in the complex angular momentum and that their contribution is not negligibly small. Several models are considered (including the so-called eikonal model) in which the parameters of the cuts are determined from the Regge ones. These models are shown to eliminate many, but not all, of the difficulties of the simple Regge model. (France)

53136 UNCONVENTIONAL ASYMPTOTICS. Phillips, R. J. N. (Rutherford High Energy Lab., Chilton, Eng.). pp III74-81 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

The constraints imposed on high-energy scattering by analyticity are discussed, using dispersion relations and finite energy sum rules (FESR). Two questions raised by the Serpukhov σ_T data are considered: i) does the Pomeranchuk theorem hold; and ii) why the sudden change of slope in σ_T vs. $p_L^{-\frac{1}{2}}$. The consequences of Regge cuts, an ionization point, Regge dipoles, complex alphas and size resonances are discussed. (France)

53137 DUALITY AND REGGE CUTS IN INELASTIC 2-BODY PROCESSES. Krzywicki, A. (Paris Univ., Orsay, France). pp III94-124 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

Some recent considerations in the phenomenology of Regge cuts are reviewed. Inelastic 2-body processes are considered, almost exclusively. The phenomenological consequences of introducing cuts, when duality between Regge poles and direct channel resonances is postulated, are examined. (France)

53138 DIPS AND SPIKES IN $d\sigma/dt$ FOR HIGH ENERGY EXCHANGE REACTIONS. Dar, A. (Technion-Israel Inst. of Tech., Haifa). pp III125-43 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

A simple interpretation of the dips and spikes observed in the t dependence of dδ/dt for high energy exchange reactions is proposed. The model is based on two main assumptions: exchange reactions are surface reactions, and the peripheral partial waves of an exchange amplitude are approximately described by the corresponding partial waves of the pole closest to the physical region. Reactions involving π-exchange are analyzed, as well as a selected set of other reactions for which analytic calculations are relatively simple. The model is in excellent agreement with the experimental observations. (France)

53139 CONCLUSIONS. Sonderegger, P. (CEA, Saclay, France). pp IV2-9 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

Models which have been used in the high energy phenomenology of the electromagnetic and strong interactions are presented including the Regge model, Veneziano model, duality, exchange degeneracy and unconventional asymptotics. The Regge pole picture and the impact parameter geometrical picture are compared. (France)

53140 SUM RULES FOR INCLUSIVE HADRONIC PROCESSES. Mahanthappa, K. T. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 2: No. 7, 326-8(14 Aug 1971).

A set of sum rules is derived for differential cross sections of the type A + B → C + anything, where A and B are initial hadrons and C is a member of the pseudoscalar–meson octet. (L.B.S.)

53141 SEPARATION OF THE RESONANCE AND BACKGROUND AND THE POSSIBILITY FOR A POMERANCHUK TERM. Fukuda, R. (Tokyo Univ.). Lett. Nuovo Cim.; 2: No. 8, 385-9(21 Aug 1971).

The theoretical means for separation of the background term from the resonance term in the total cross section are discussed. The conclusion is reached that the background term is just minus the value of the amplitude on the unphysical sheet at the same point on the physical sheet. The consequences of this method for the Pomeranchuk term are also discussed. It is concluded that the Pomeranchuk term is the manifestation of the value of the amplitude on the unphysical sheet. (L.B.S.)

53142 NE'EMAN'S FIFTH INTERACTION AND OCTET DOMINANCE IN NONLEPTONIC DECAYS. Szymacha, A.; Tatur, S. (Univ., Warsaw). Lett. Nuovo Cim.; 2: No. 7, 345-8(14 Aug 1971).

Following the model of Ne'eman for strong interactions, an effective Hamiltonian is obtained that has the desired octet transformation properties and does not vanish for physical processes. (L.B.S.)

53143 INCREASE OF ELECTROMAGNETIC AND WEAK CORRECTIONS TO HADRON SCATTERING WITH GROWTH OF ENERGY. Frankfurt, L. L. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 61: No. 1, 45-55(Jul 1971). (In Russian).

It is shown that for strong interactions occurring at large distances (increasing with energy), the electromagnetic and weak corrections to hadron scattering should increase with the energy. Violation of isotopic invariance (due to electromagnetic corrections) and violation of spatial parity (due to weak corrections) expected at high energies are estimated. (auth)

53144 DETERMINATION OF FIREBALL PARAMETERS IN ACCELERATOR AND COSMIC-RAY PRODUCED JETS. Agnese, A. G.; Wataghin, A. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo Cim.; 5A: No. 1, 1-8(1 Sep 1971).

A new method for identifying fireballs in cosmic-ray or accelerator produced jets and for measuring the parameters p_0 (and consequently the decay temperature of the fireball in the context of a statistical model), and γ_b is suggested. The method is applied to two events. The main result is that $p_0 \simeq 130$ MeV/c. (auth)

53145 RELATIONS BETWEEN THE FEYNMAN GAS AND MULTIPERIPHERAL MODELS. Le Bellac, M. (Univ., Nice). Lett. Nuovo Cim.; 2: No. 9, 437-40(28 Aug 1971).

Relations between the n-particle production cross sections and the inclusive cross sections $d\sigma/d^3q_1 \ldots d^3q_N$ for two particles going into N particles with momenta $q_1, \ldots q_3$ were derived by Mueller in the framework of the multiperipheral model and then generalized to the case of the Feynman-gas model. Some consequences of Mueller's result for the Feynman-gas model are examined; it is first shown that an important generating function has a Regge-like behavior, and that the production cross sections behave in a way which is strongly reminiscent of the multiperipheral model. The behavior of the moments of multiplicity is also discussed. Brief comments are made on the role of the coupling constant in the Feynman gas model. (L.B.S.)

53146 INFLUENCE OF THE BREIT–WIGNER TYPE OF INSTABILITY ON ANALYTIC PROPERTIES OF PARTIAL-WAVE AMPLITUDES. Blazek, M. (Inst. of Physics, Bratislava). Czech. J. Phys.; 21: No. 7, 749-67(1971).

The relativistic binary processes are considered. For a general mass case the partial wave projection of an invariant amplitude involves some necessary continuation due to the appearance of the areas where the Mandelstam denominators vanish if the kinematical quantities have their physical values. To avoid the corresponding difficulties and to be able to perform practical and realistic calculations, the invariant amplitudes are expressed in terms of the exchanged stable and unstable objects and then they are projected onto the partial waves. Their analytic properties in the complex energy squared plane are investigated in more detail. As the first approximation, the unstable objects are expressed in the Breit–Wigner form. (auth)

53147 KINEMATIC ASPECTS OF INCLUSIVE PHENOMENOLOGY. Berger, E. L.; Krzywicki, A. (Laboratoire de Physique Theorique et Particules Elementaires, Orsay, France). Phys. Lett.; 36B: No. 4, 380-4(20 Sep 1971).

Several kinematics aspects of inclusive phenomenology are discussed. First, it is shown that there are two energy regimes. In the lower regime, where $p_{lab} \lesssim 100$ GeV/c, mean multiplicity $\langle n \rangle$ of produced particles may increase as a power of energy; only in the higher energy region should one expect $\langle n \rangle \sim \log s$. Second, correlations between produced secondaries are treated. Important correlations are expected for purely kinematic reasons, as a reflection of small inelasticity of through-going particles in NN or meson–nucleon reactions. These kinematic correlations imitate correlations associated with dynamical effects. Third, questions are raised with respect to interpretation of shapes of single-particle inclusive distributions. (auth)

53148 IMPROVEMENT OF THE FROISSART BOUND. Uchiyama, Tadashi (Osaka City Univ. Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1960-6(Jun 1971).

Assuming the unitarity and analyticity in t of the scattering amplitude, the asymptotic upper bound on the behavior of total cross sections at high energies is obtained. In this upper bound all the terms tending to infinity for $s \to \infty$ are included. This and the polynomial boundedness of the scattering amplitude lead to the Froissart bound including the bound of the coefficient of the asymptotic expansion. It is shown that the Froissart bound including its coefficient cannot be improved. It is suggested that the first term of the asymptotic expansion dominates over other terms for the c.m. energies higher than 10^{38} GeV. (auth)

53149 HADRON REACTIONS AND URBARYON REARRANGEMENT. I. EFFECTIVE RESONANCE STRUCTURE. Imachi, Masahiro; Oroguchi, Takashige; Otsuki, Shoichiro; Toyoda, Fumihiko (Kyushu Univ., Fukuoka. Kinki Univ., Iizuka, Japan). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1849-78(Jun 1971).

By incorporating dynamical aspects of hadron reactions, which closely correspond to the pattern of the urbaryon rearrangement diagram (URD), P_8-B_8 reaction amplitude is constructed in the impact parameter representation. The main dynamical aspects are that the impact parameter to form observed resonances in P_8-B_8 reaction takes an almost universal value and that angular distributions have almost energy-independent dips (with the positions $t_0 : t_1 : t_2$ and/or $u'_1 : u'_1 : u'_2 \simeq 1 : 4 : 9$) in such processes that contain the H(s-t dual) and/or Z(s-u dual) type URD amplitudes. Then the interaction densities of these amplitudes are peaked at a constant value b_0 of the impact parameter, which we call resonant interaction density. The constant b_0 implies a bending effective resonance trajectory $\alpha_{\text{eff}} \underset{s \gg 1}{\sim} \sqrt{s}$, and α_{eff} coincides with leading trajectories when s is not large. On the contrary, the interaction density of the X(t-u dual) type URD amplitude has a simple Gaussian form. The s dependence of the interaction densities is described by $s^{-\gamma n_R}$ with $\gamma \sim 0.5$, where n_R denotes the number of rearranged urbaryons. Quantitative fit of the amplitude to elastic π-N scattering in the forward hemi-sphere and qualitative fit to other P_8-B_8 reactions in the forward and the backward regions are given. The effective resonances in the URD amplitude and the $s^{-\gamma n_R}$ behaviour imply systematic correlations of resonances in the hadron level and may afford clues to the nature of the urbaryon. The interaction densities are related to hadron electromagnetic form factors. (auth)

53150 MODEL FOR QUASIPOTENTIAL HADRON DIFFRACTION. Potupa, A. S. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 5, 117-19(1970). (In Russian).

XUM

For Regge behavior of the radius of strong interactions at high energies ($R \sim (\ln E)^{1/2}$, where E is energy) the analogy between hadron elastic scattering and the diffraction of waves on a black sphere is decreased as $E \rightarrow \infty$. It is shown that by a close analogy hadron diffraction is the scattering of waves on an oscillating ground state absorbing point. (tr-auth)

53151 HADRON FORM FACTORS, DEEP-INELASTIC ELECTROPRODUCTION, AND MASSIVE-LEPTON PAIR PRODUCTION: KINEMATICS OR DYNAMICS? Cocho, G.; Salazar, J. J. (Univ. de Mexico, Mexico City). Phys. Rev. Lett.; 27: No. 13, 892-5 (27 Sep 1971).

A theoretical model for the hadrons as extended objects is discussed. The size and shape of hadrons are taken into account by means of an algebraic harmonic-oscillator formalism. This model can explain, with essentially the same parameters, the magnetic form factor of the proton, deep-inelastic electroproduction, and $\mu^+\mu^-$ pair production at high energy. The model is also consistent with the known experimental data on the spacelike and timelike pion form factor. (auth)

53152 SOME CONSEQUENCES OF A MODIFIED QUARK MODEL INVOLVING SCHWINGER TERMS. Gomberoff, Luis; Rangwala, Abbas A. (Tel-Aviv Univ., Israel). Nucl. Phys.; B31: No. 2, 512-16(1971).

It is shown that the modified quark-model algebra of Mendes and Ne'eman reduces, in the SU(2) × SU(2) limit, to the usual SU(3) × SU(3) quark-model algebra. (auth)

53153 EXPLOSIONS AND MULTI-PERIPHERALISM. Halliday, I. G. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B31: No. 2, 517-30(1971).

The explosive domain of strong interaction production processes where E^{γ} particles are produced as the laboratory energy E tends to infinity is studied. The kinematics of this region are in such sharp disagreement with multiperipheral kinematics that multiperipheral models are probably inapplicable. As a guide to discussing models the volume of phase space in the explosive limit, both in two and four dimensions, are then examined. These results lead to a discussion of possible experimental tests as to whether the explosive or multi-peripheral domains dominate the total cross section. (auth)

53154 FINITE-ENERGY CURRENT ALGEBRA SUM RULES. Ellis, J.; Weisz, P. H. (CERN, Geneva). Nuovo Cim.; 4A: No. 4, 873-82(21 Aug 1971).

Using the finite-contour method a modified Adler–Weisberger relation is derived. A similar technique yields a sum rule from the charge-current divergence commutator. The sum rules are evaluated by means of Regge models with "unconventional" asymptotic behavior. Models with weak nonabsorptive cuts are not favored. (auth)

53155 MULTI-PERIPHERAL DYNAMICS. Frazer, W. R. (Univ. of California, La Jolla). pp 311-24 of Eighth Annual Eastern Theoretical Physics Conference Proceedings. /Rohrlich, F. (ed.). Syracuse, N. Y.; Syracuse Univ. (1969).

From eighth eastern theoretical physics conference; Syracuse, N. Y. (10 Oct 1969). See CONF-691033.

Multiperipheral dynamics for strong interactions is reviewed. Also mentioned are perturbation theory, potential scattering, the Bethe–Salpeter equation, the N/D method, the strip approximation, and finite-energy-sum-rule bootstraps. (J.F.P.)

53156 DUALITY AND SINGLE-PARTICLE PRODUCTION. DeTar, C. E. (Massachusetts Inst. of Tech., Cambridge); Kang, Kyungsik; Tan, Chung-i; Weis, J. H. Phys. Rev., D; 4: No. 2, 425-39(15 Jul 1971).

Following Mueller, the single-particle production cross section for the process $a + b \rightarrow x +$ anything is related to a discontinuity of the six-line amplitude $a + b + \bar{x} \rightarrow a + b + \bar{x}$. Using the dual-resonance model for the six-line amplitude, an explicit form for the production cross section at high energies is obtained. The formula exhibits the expected features of limiting fragmentation, an invariant central region, and triple-Regge asymptotic behavior. In addition, it has a universal cutoff in transverse momentum of the form $e^{-4bp_{\perp}^2}$ in the central region, where b is the universal trajectory slope. For particle production some general consequences of duality in the missing mass are discussed. For example, the behavior of two-body scattering amplitudes at wide angles is related to the transverse-momentum dependence of production cross sections. Finally, the possible experimental relevance of the results is discussed. (auth)

53157 s-CHANNEL HELICITY CONSERVATION CONSTRAINTS ON t-CHANNEL EXCHANGES. Blackmon, Maurice L.; King, Marcia J.; Wali, Kameshwar C. (Syracuse Univ., N. Y.). Phys. Rev., D; 4: No. 2, 559-69(15 Jul 1971).

Equations relating t-channel Regge residue functions are derived, assuming that s-channel helicity is conserved. When these equations are extrapolated to the positive t region, they become constraints on coupling constants for the exchanged particles. It is shown that assuming helicity conservation in reactions $\pi\pi \rightarrow \pi S(\pi N \rightarrow \pi N^*)$, the exchanged particles have a unique coupling, and they have angular momentum J such that $J \geq S$ ($J \geq S + 1/2$), where S is the angular momentum of the meson resonance S (baryon resonance N*). Detailed examples are given. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 53027, 53183, 53288, and 53336.

53158 THREE-BODY DECAYS OF VECTOR MESONS IN A QUARK MODEL. Esteve, A.; Navarro, J. M.; Tiemblo, A. (Instituto Rocasolano, Madrid. GIFT, Madrid). Nuovo Cim.; 4A: No. 4: 743-8(21 Aug 1971).

The PVV vertex appearing in the pole model calculations for the three-body decays of vector mesons is substituted by a loop of quarks. It is assumed that $m_\lambda \gg m$ and both are very large. The model gives the right value for $\Gamma_{\omega\rightarrow 3\pi}/\Gamma_{\omega\rightarrow\pi^0\gamma}$ and explains the depression of the decays $K^* \rightarrow K\pi\pi$. (auth)

53159 EXCHANGE DEGENERACY AND ABSORPTION: πN, KN AND NN REACTIONS. Drouffe, J. M.; Navelet, H. (CEA, Saclay, France). pp III144-57 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

The Reggeized absorption model with exchange degeneracy is formulated in all its generality. The analysis of this model is extended to study πN, $\bar{K}N$, KN, $\bar{N}N$, and NN elastic and charge-exchange reactions in a unified way. With an economical set of parameters, quite satisfactory fits are obtained of all the available experimental data. (France)

53160 RESONANCE SPECTRUM IN THE VENEZIANO MODEL. Le Bellac, M. (Euorpean Organization for Nuclear Research, Geneva). pp III179-92 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

The amplitude for the N-point Veneziano function for scalar mesons is described in an operator formalism by giving a kind of Feynman rules for vertices and propagators. The property of factorization gives the spectrum of the theory, which is related to the states of a harmonic oscillator. The degeneracy is shown to increase exponentially as the mass goes to infinity. (France)

53161 PION VERTEX FUNCTIONS FROM THE SPURION MODEL AND VENEZIANO FORMULA. Dominguez, C. A.; Zandron, O. (Univ. of Buenos Aires). Lett. Nuovo Cim.; 2: No. 7, 371-5(14 Aug 1971).

It is shown how the spurion model can be applied to obtain the axial vector and scalar form factors of the pion. In both cases the resultant expressions are found to have undesired features, in contrast with the result obtained by means of current algebra sum rules. It is suggested that the spurion model provides a limited or even dubious method for computing vertex functions. (L.B.S.)

53162 KHURI ANALYSIS OF THE $\eta^0\eta^0$ VIRASORO AMPLITUDE. Kennedy, W. L.; Oh, C. H. (Univ. of Otago, Dunedin, N. Z.). Lett. Nuovo Cim.; 1: No. 26, 1091-4(26 Jun 1971).

The Khuri-plane structure of the Virasoro amplitude for $\eta^0\eta^0$ scattering is analyzed. It is shown that the Virasoro amplitude is regular in the finite ν-plane except for moving Khuri poles. It is concluded that the Khuri-plane pole structure of the Virasoro model is similar to that of the Veneziano model; in both cases there is an infinite sequence of Khuri poles at $\nu - \alpha(s) - n$ with residues β_n. (L.B.S.)

53163 POSSIBILITY OF OBTAINING ASYMPTOTICALLY DECREASING EFIMOV AMPLITUDES. Georgalas, G. G. (Democritus Nuclear Research Center, Athens). Lett. Nuovo Cim.; 2: No. 7, 337-41(14 Aug 1971).

Calculations of the Efimov amplitudes in nonpolynomial Lagrangian models have yielded an exponential increase as $S \rightarrow +\infty$, which is inconsistent with experimental data for some processes and also with Orear's formula. The possibility of avoiding this result by changing the formalism or its interpretation is examined. (L.B.S.)

53164 CURRENT ALGEBRA, UNITARITY, AND S-WAVE Kπ SCATTERING. Carrotte, J. B. (Univ. of Durham, Eng.). Lett. Nuovo Cim.; 2: No. 10, 503-6(4 Sep 1971).

Current algebra techniques used to obtain an expression for the πK scattering amplitude in the low-energy limit are combined with elastic unitarity and the effective range approximation to obtain S-wave πK scattering lengths and phase shifts up to the resonance region. (L.B.S.)

53165 MODEL FOR LOW-ENERGY $\pi\pi$ SCATTERING. Baier, R. (Univ., Graz); Kuehnelt, H.; Widder, F. Acta Phys. Austr.; 32: No. 1, 65-77(1970).

A method for unitarization of crossing symmetric, but real amplitudes is proposed and applied to Weinberg's $\pi\pi$ scattering amplitudes. Exact conditions on partial wave amplitudes following from general principles turn out to be very useful in constraining otherwise undetermined parameters. Resonating phase shifts are found. (auth)

53166 REDUCED-MOMENT PROBLEM AND CONSTRAINTS ON PARTIAL-WAVE AMPLITUDES FOR $\pi\pi \rightarrow \pi\pi$ AND $\pi\pi \rightarrow N\overline{N}$ SCATTERING. Common, A. K. (Univ. of Kent, Canterbury, Eng.); Pennington, M. R. Lett. Nuovo Cim.; 2: No. 9, 429-33 (28 Aug 1971).

The reduced-moment problem is used to derive the necessary and sufficient conditions for a finite number of partial waves for $\pi\pi \rightarrow \pi\pi$ and $\pi\pi \rightarrow N\overline{N}$ to have the representation $f_l(s) = \int_{\mu_0}^{\infty} d\varphi(z,s)\, z^{-l-1}$. (L.B.S.)

53167 UNIVERSALITY OF THE TWO-PION ISOVECTOR COUPLING. Fabricius, K.; Kramer, G. (Univ., Hamburg). Acta Phys. Austr.; 32: No. 1, 35-46(1970).

The Adler–Weisberger universality is derived from a new gauge invariance of the S-matrix. Then former attempts to prove the universality of pion-baryon scattering from the Adler self-consistency condition are discussed and a counter example is given. The result is compared with the experimental data. (auth)

53168 OFF-MASS-SHELL DEPENDENCE OF THE A_2-MESON. Milgram, M. S.; Moffat, J. W. (Univ. of Toronto). Lett. Nuovo Cim.; 2: No. 11, 555-9(11 Sep 1971).

It is pointed out that experiments recently performed to detect the splitting of the A_2-meson have revealed no structure of this resonance in contradiction to a series of CERN experiments. A dipole model is used to fit the experimental data. It is concluded that the apparent contradiction between the CERN missing-mass experiments and the Boston-Northeastern-Stony Brook missing-mass experiment may be due to multichannel interference effects because of the unknown identity of the final states. (L.B.S.)

53169 IMPLICATIONS OF DUALITY FOR $\overline{K}K$ RESONANCES AND A2 SPLITTING. Iwao, Syurei (Kanazawa Univ., Japan). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1992–4(Jun 1971).

Semilocal duality is applied to meson–meson scattering under the following assumptions: the semilocal duality applies to different isospin amplitudes separately; the imaginary part of the backward integrated amplitude with a definite isospin in a certain range of energy saturates the sum rule if the corresponding amplitude in the crossed u(t) channel belongs to the exotic state; and the direct channel amplitudes may be approximated by the resonance states in the narrow width approximation. The partial $\overline{K}K$ decay width of A2 is predicted to be 14-15 MeV for both a single and double structure of A2. Thus it is suggested that the question on this resonant state may be clarified by the detailed study of the branching probability of A2 in $\overline{K}K$ decay. (L.B.S.)

53170 NONLINEAR EQUATIONS FOR THE ELECTRODYNAMICS OF SCALAR MESONS. Fedorov, F. I.; Kuvshinov, V. I. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 5, 69-75(1970). (In Russian).

Equations for interacting electromagnetic and scalar meson fields were given in general form $(\gamma^k \partial k + \gamma^0)\Psi + \Psi\Lambda\Psi = 0$, where the quadratic matrices of γ^k, γ^0 and the third-rank matrix Λ have dimension 20. The properties of these matrices were examined. The Lagrangian function was obtained for general field and projection operators, excluding possible states for the case of noninteracting fields. (tr-auth)

53171 FINAL STATE INTERACTIONS IN THE VENEZIANO MODEL. Chiang, H. C. (National Tsing Hua Univ., Hsinchu, Taiwan). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1827-36(Jun 1971).

The final state interactions parametrized by a scattering length and a low energy resonance are considered in the Veneziano type model. The resulting amplitude is shown to satisfy the unitarity equation approximately in the low energy region. The high energy behavior of the amplitude is examined. It is concluded that the correct high energy behavior is maintained in the model. (auth)

53172 EXACT INTEGRAL EQUATION FOR PION–PION SCATTERING INVOLVING ONLY PHYSICAL REGION PARTIAL WAVES. Roy, S. M. (CERN, Geneva). Phys. Lett.; 36B: No. 4, 353-6(20 Sep 1971).

An exact relation is derived for $\pi\pi$ scattering which yields the real parts of the $\pi\pi$ partial wave amplitudes $a_l^{(I)}(s)$ in the region $4m_\pi^2 \leq s \leq 60m_\pi^2$, given i) the I = 0 and the I = 2 S wave scattering lengths and ii) the Im $a_l^{(I)}(s)$ for $4m_\pi^2 \leq s \leq \infty$, where $\sqrt{s}$ denotes the centre-of-mass energy, l the angular momentum and I the isotopic spin. It also provides i) a system of integral equations to determine the $a_l^{(I)}(s)$ for $4m_\pi^2 \leq s \leq 16m_\pi^2$, $16m_\pi^2 \leq s \leq \infty$, and ii) necessary and sufficient conditions for crossing symmetry expressed in terms of the physical region partial wave amplitudes only. (auth)

53173 DUALITY AND RELATIVISTIC SU(6) SYMMETRY. Franzen, G. (Univ.,Bonn). Nucl. Phys.; B31: No. 2, 575-88(1971).

A recently derived model for the N-meson amplitude without parity doublets is investigated in detail. The incorporation of charge conjugation invariance and signature is performed. The asymptotic behavior and the j-plane singularities are carefully discussed. The model is finally generalized to meson–baryon scattering. (auth)

53174 UNIFIED TREATMENT OF PHOTON AND MASSIVE VECTOR-MESON SCATTERING PROCESS BY HELICITY AMPLITUDES. Akiba, T. (Tohoku Univ., Sendai); Sakuraoka, M.; Ebata, T. Nucl. Phys.; B31: No. 2, 381-99(1971).

A formalism to treat virtual photons and massive vector mesons on the essentially same footing is developed to include the scattering of a massless and massive spin-1 particle by a spin-½ particle. It is explicitly shown that a smooth limit of the massive case amplitudes to the Compton amplitudes can be realized within the framework of helicity amplitudes and that the zero-mass limit satisfies all the requirements of gauge invariance. Such a formalism is advantageous to incorporate the vector-dominance hypothesis and yields a convenient parametrization of helicity amplitudes for the Regge-pole analysis of real and virtual photon processes. (auth)

53175 GROUP-THEORETIC DERIVATION OF CROSSING SUM RULES. Cooper, C. S.; Pennington, M. R. (Westfield Coll., London). J. Math. Phys. (N. Y.); 12: No. 8, 1509-15(Aug 1971).

Crossing relations between amplitudes with definite isospin for $\pi\pi$ scattering are expressed in terms of the symmetric group S_3. The sum rules, involving s-channel partial wave amplitudes, are then derived without reference to the previous expansion and are shown to be a direct consequence of the group-theoretic orthogonality relations. This results in closed expressions for all possible sum rules. (auth)

53176 KINKS AND THE DIRAC EQUATION. Skyrme, T. H. R. (Univ. of Birmingham, Eng.). J. Math. Phys. (N. Y.); 12: No. 8, 1735-43(Aug 1971).

In a model quantum theory of interacting mesons, the motion of certain conserved particlelike structures is discussed. It is shown how collective coordinates may be introduced to describe them, leading, in lowest approximation, to a Dirac equation. (auth)

53177 ANALYSIS OF THE ANNIHILATION PROCESS $\overline{p}p - \eta\pi^+\pi^-$ AT REST USING VENEZIANO-TYPE AMPLITUDES. Chung, S. U.; Montanet, L.; Reucroft, S.; Witt-Hansen, O. (CERN, Geneva). Nucl. Phys.; B31: No. 2, 261-8(1971).

Reasonable fits to the data were obtained by using Veneziano-type amplitudes with trajectories corresponding to the ρ, f and A_2 mesons, to represent the singlet and triplet states of the $\overline{p}p$ annihilation at rest. (auth)

Strong (Baryon No. = 1)

Refer also to abstract 53029.

53178 (NYO–4204-19) SUM RULE FOR CHIRAL SU(2)xSU(2) SYMMETRY BREAKING. Li, Ling-Fong; Pagels, Heinz (Rockefeller Univ., New York). [1971]. Contract AT(30-1)-4204. 12p. Dep. NTIS.

A sum rule is derived for chiral SU(2) × SU(2) breaking parameters of the form $\Delta_\pi = -\sigma/M_N + C(0)$ where $\Delta_\pi = 1 - 2Mg_A/\sqrt{2}gf_\pi \simeq 0.08$ are the corrections to the Goldberger–Treiman formula, σ is the sigma term in pion-nucleon scattering estimated previously to be ~110 MeV, and C(0) represents a continuum contribution related to the change in the reduced pion-nucleon Regge residue. The behavior of this reduced residue as obtained from an analysis of strong and electromagnetic processes suggests that C(0) has

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both the correct sign and approximate magnitude to satisfy the sum rule. (auth)

53179 (UCRL-20655, pp 169-75) PARTIAL WAVE ANALYSIS AND EXPERIMENT IN πN REACTIONS. Moorhouse, R. G. (California Univ., Berkeley). Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

The probable structure of scattering amplitudes in the framework of Harari–Freund duality and the way to make the best use of this structure in partial-wave analysis are first discussed. The importance of experiments on $\pi^- p \rightarrow \pi^0 n$, $\pi^- p \rightarrow K^0 \Lambda$, and $\pi^+ p \rightarrow K^+ \Sigma^+$ interactions for testing the Harari–Freund hypothesis and for finding the higher-energy, low angular momentum N^* resonances is then briefly discussed. (L.B.S.)

53180 (UCRL-20655, pp 176a-89) REMARKS ON K–N AND N–N PARTIAL WAVE ANALYSIS. Moravcsik, Michael J. (Oregon Univ., Eugene). Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

Two recent phenomenological developments which indicate that partial wave decompositions might be feasible at all energies are outlined—the method of optimalized expansion, and the phase-band method. Comments are then made on what type of experiments should be performed for partial wave analysis, taking into account the two methods. A few remarks are made on the search for exotic resonances. (L.B.S.)

53181 (UCRL-20655, pp 190a-202) LOW AND INTERMEDIATE ENERGY $\bar{K}N$ EXPERIMENTS. Tripp, R. D. (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

An experimental view of K^- formation experiments at low and intermediate energies is presented. A summary of what has been done and some further needs in bubble chamber experiments, electronic experiments, and multichannel partial-wave analysis is given. (L.B.S.)

53182 (UCRL-20655, pp 220a-49) PARTIAL WAVE ANALYSES IN MULTIPARTICLE FINAL STATES. Cashmore, R. J. Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

The analysis of formation processes with three-body final states is discussed in terms of model independent and model dependent methods. Results are presented for the $\pi^- p \rightarrow \pi^+ + \pi^- + n$ interactions. It is concluded that reasonable solutions to the three-body data can be obtained within the isobar model. It is suggested that measurements of final nucleon polarization and scattering from polarized targets will improve the analysis. (L.B.S.)

53183 (UCRL-20655, pp 250a-76) INTERFERING BOSON RESONANCES AS A TOOL IN STRONG INTERACTIONS AND SEARCH FOR C VIOLATION IN THE ELECTROMAGNETIC OR SEMI-STRONG INTERACTIONS. Goldhaber, Gerson (California Univ., Berkeley). Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

Some specific ideas for future experiments centering on the interference of the ω and ρ^0 are presented. It is suggested that a very accurate experiment could be performed on the reactions $\pi^+ n \rightarrow \pi^+ \pi^- p$ and $\pi^- p \rightarrow \pi^+ \pi^- n$ to study the breakdown of charge symmetry induced by ω-ρ mass mixing. The search for C violation in ρ decay using the ρ-ω interference effect is also suggested. (L.B.S.)

53184 MODEL INDEPENDENT ANALYSIS OF HIGH ENERGY EXPERIMENTAL DATA. Tran Thanh Van, J. (Paris Univ., Orsay, France). pp III3-12 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

A method of analysis is studied which allows an unambiguous interpretation of experimental data (such as differential cross sections or density matrix elements) by extracting the contributions due to the exchange of a definite set of quantum numbers. The formalism is applied to $\pi N \rightarrow \rho N$ to isolate the ω exchange contribution (I = 0). Some examples using the separation between the exchange of natural parity and of unnatural parity are also examined. (France)

53185 DIP STRUCTURE MECHANISM AND RATIO OF π^0 PHOTOPRODUCTION ON PROTON AND NEUTRON. Tran Thanh Van, J. (Paris Univ., Orsay, France). pp III13-23 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

The dip structure at $t \simeq -0.6$ GeV^2 in several reactions allowing ρ or ω exchange is discussed. It is shown that the absorptive corrections in the conventional absorption theory are small in these reactions and are not able to fill the dip due to nonsense wrong signature points, and that B meson exchange gives important contributions especially in $\pi N \rightarrow \omega N$. The presence or absence of dips in these reactions is correctly predicted, as well as the existence of dips in the ratio of π^0 photoproduction on neutrons and on protons and in backward scattering ($\pi^+ p$ or $K^- n$). (France)

53186 POLARIZATION IN ELASTIC SCATTERING AT HIGH ENERGY. Bellettini, G. (Istituto Nazionale di Fisica Nucleare, Pisa, Italy). pp III32-43 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

Compilations of recoil proton polarization data for $\pi^- p$ and $\pi^+ p$ forward scattering are presented and compared. Polarization data for Kp, pp and $\bar{p}p$ elastic scattering are also presented and interpreted with an exchange–degenerate Regge-pole model. (France)

53187 PION–NUCLEON BACKWARD SCATTERING IN THE ABSORPTION MODEL. Schiff, D.; Schneider, J. (Paris Univ., Orsay, France). pp III168-78 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

Pion-nucleon backward scattering is investigated using the traditional absorption model. It is concluded that the data for $\pi^- p \rightarrow p\pi^-$ and $\pi^+ p \rightarrow p\pi^+$ as well as small u points of $\pi^- p \rightarrow n\pi^0$ can be described qualitatively with the N_α and Δ trajectories. To describe the larger u data for $\pi^- p \rightarrow n\pi^0$, an N_γ contribution which is large and strongly absorbed is introduced. (France)

53188 PHENOMENOLOGICAL ANALYSES WITH DUAL FIVE-POINT FUNCTIONS. Kajantie, K. (European Organization for Nuclear Research, Geneva). pp III193-204 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

The dual five-point function B_5 is described. Its application to the realistic case $\bar{K}N \rightarrow \bar{K}\pi N$ is considered, with emphasis on the problems to be solved. Further problems, following from the combination of B_5 with internal symmetries, are discussed. (France)

53189 THEOREM ON THE VANISHING OF Z_2: EVIDENCE FROM ELECTRON SCATTERING THAT THE PROTON REALLY IS A COMPOSITE PARTICLE. West, Geoffrey B. (Stanford Univ., Calif.). Phys. Rev. Lett.; 27: No. 11, 762-5(13 Sep 1971).

It is proven that the asymptotic vanishing of the longitudinal part of the total virtual photoabsorption cross section on protons implies the vanishing of the wave-function renormalization constant Z_2. Present data indicate that $Z_2 \lesssim 0.1$ (consistent with zero) suggesting that the proton is indeed a composite particle. (auth)

53190 ANALYSIS OF THE REACTIONS $K^+ p \rightarrow \bar{\Lambda} pp$, $pp \rightarrow K^+ \Lambda p$ AND $K^- p \rightarrow \Lambda \bar{p} p$ WITH THE GENERALIZED VENEZIANO MODEL. Dunwoodie, W. M.; Tuominiemi, J. K. (European Organization for Nuclear Research, Geneva). Commentat. Phys.-Math.; 40: 119-33 (1970).

The reactions $K^+ p \rightarrow \bar{\Lambda} pp$, $pp \rightarrow K^+ \Lambda p$, $K^- p \rightarrow \Lambda \bar{p} p$ with the generalized Veneziano model at several incoming momenta were analyzed. While a degree of qualitative agreement was achieved it seemed indicated that the ω trajectory in the $\bar{p}p$-channels of the relevant five point amplitudes should have been replaced by the pion trajectory or the Pomeron. The previous diffraction dissociation model was also applied to the K^+-p reactions; it was found to reproduce the c.m. angular distributions quite acceptably except in the case of the $\bar{\Lambda}$. This, together with the behavior of the total cross section for $K^+ p \rightarrow \bar{\Lambda} pp$, indicated that a purely diffractive production was inappropriate to a description of the data. It is concluded that a superposition of diffractive and dual resonance amplitudes is required, but such a model cannot be formulated because of difficulties associated with the pion trajectory. (auth) (FINLAND)

53191 SOME APPLICATIONS OF CURRENT ALGEBRAS. Radescu, E. E. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 4, 437-76(1971). (In Rumanian).

Current algebra sum rules for πN-scattering amplitudes in the soft pion limit, $SU_2 \times SU_2$ asymptotic symmetry and sum rules for πN amplitudes, the Fubini, Furlan, de Alfaro and Rossetti extrapolation method, and πN-s-wave effective ranges and p-wave scattering length are discussed. (auth)

53192 DETERMINATION OF THE KAON–NUCLEON Σ-TERM. Thompson, G. D. (Univ. of Glasgow). Lett. Nuovo Cim.; 2: No. 8, 424-8(21 Aug 1971).

The proton matrix element of the kaon Σ-commutator in K^+p scattering is calculated using a threshold subtracted fixed-t dispersion relation. (L.B.S.)

53193 APPLICATION OF DUALITY DIAGRAMS TO THE MULTIPERIPHERAL DESCRIPTIONS OF MANY-BODY PROCESSES. Bozki, G. (Univ. of Pennsylvania, Philadelphia); Gombosi, E.; Hofmokl, T. Lett. Nuovo Cim.; 1: No. 26, 1099-1104(26 Jun 1971).

Nucleon momentum distributions for multiperipheral interactions of the type $\pi N \rightarrow N + k\pi$ are studied by applying duality diagrams and using the assumption that the primary particles are neighbors on the diagrams. (L.B.S.)

53194 RELATIVISTICALLY INVARIANT EQUATION FOR BARYONS IN SCHWINGER MODEL. Masleev, N. N. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 4, 33-40(Jul-Aug 1970). (In Russian).

Assuming, following Schwinger, that baryons consist of two particles, one of which is a fermion and the other a boson, an equation is deduced, which describes baryons in the free state and in the presence of a weak electromagnetic field. It is assumed that the masses of the constituent baryons and particles are different and great in comparison with their momenta. Since in the model used, baryons are composed from various-spin particles, there is no inconsistency with statistics for the usual quark models. (tr-auth)

53195 TENSOR-MESON DOMINANCE AND REGGE COUPLINGS. Freund, P. G. O. (Univ. of Chicago). Nuovo Cim.; 5A: No. 1, 9-18(1 Sep 1971).

The helicity structure of mesonic Regge couplings is discussed in the context of meson pole dominance for the matrix elements of vector currents and of the energy-momentum tensor. Experimental tests of this helicity structure are proposed. The obtained couplings are incompatible with the $U_{6W} \times O_{2L_z}$ symmetric quark model, and they, therefore, provide a guide toward $U_{6W} \times O_{2L_z}$ symmetry breaking. Universal couplings for higher-spin ($J > 2$) mesons are considered. (auth)

53196 ρ REGGE-TRAJECTORY INTERCEPT AT $t = 0$ AND REGGE-CUT EFFECT IN FORWARD PION–NUCLEON SCATTERING. Masuda, N. (Louisiana State Univ., Baton Rouge). Lett. Nuovo Cim.; 2: No. 10, 531-6(4 Sep 1971).

The absorptive Regge cut model is applied to forward pion–nucleon scattering in order to determine the ρ-trajectory intercept $\alpha_\rho(0)$ at $t = 0$ and other Regge trajectory parameters. The results of fits to the π^+p and π^-p data yield a value $\alpha_\rho(0) = 0.44$, which agrees with the value determined from the straight-line trajectory. (L.B.S.)

53197 ENERGY DEPENDENCE OF THE SLOPE OF THE πN DIFFRACTION AMPLITUDE. Hoehler, G.; Jakob, H. P, (Univ., Karlsruhe, Ger.). Lett. Nuovo Cim.; 2: No. 10, 485-92(4 Sep 1971).

Dispersion relations predictions for the energy dependence of the slope of the real part of the πN diffraction amplitude are studied. The evaluation of the dispersion relation was made for several high-energy assumptions, which gives a continuous transition to the integrand obtained from phase shifts up to 2 GeV/c. The different predictions are compared with calculations directly from phase shifts; agreement is found at low energies. (L.B.S.)

53198 STATIC MODEL VS. THE QUARK MODEL ($\pi\Delta$ SCATTERING). Lyth, D. H.; York, M. J. (Univ. of Lancaster, Eng.). Lett. Nuovo Cim.; 2: No. 11, 577-9(11 Sep 1971).

The dynamic corrections to the static model for $\pi\Delta$ scattering in the P_{55} state are calculated using convergent fixed-t dispersion relations. All known sum rules for $\pi\Delta$ scattering are also evaluated. It is concluded that neither dispersion relations nor sum rules demand a strong P_{55} interaction. (L.B.S.)

53199 SPIN-DEPENDENT DROPLET MODEL FOR HIGH-ENERGY PION–NUCLEON ELASTIC SCATTERING. Craigie, N. S. (Univ., Heidelberg). Z. Phys.; 246: No. 2, 104-22(1971).

The Chou–Yang droplet model of hadron-hadron diffractive scattering is reinterpreted in a way that allows the spin structure of the amplitudes to be incorporated. The model is developed in the particular case of pion-nucleon elastic collisions, in which the A(+) and A′(+) amplitudes are related respectively to the F_2 and F_1 Dirac form factors of the nucleon. A version of the model, which does not conserve s-channel helicities, is first considered and its predictions compared with the high energy $\pi \pm p$ elastic data, including polarization. Finally an interpretation of asymptotic helicity conservation is provided in terms of the model. (auth)

53200 INVARIANTS OF $\pi N \rightarrow \pi B_s$. Khan, M. N.; Arif-Uz-Zaman (Univ. of Islamabad, Rawalpindi, Pakistan). J. Math. Phys. (N. Y.); 12: No. 7, 1059-66(Jul 1971).

The kinematic singularities and threshold relations of helicity amplitudes for inelastic pion-nucleon scattering involving higher baryons in the final state are discussed. A recipe for writing the s- and t-channel helicity amplitudes is obtained using Wigner–Bargmann formalism. Explicit expressions for helicity amplitudes are worked out for the processes where the final-state baryon has spin $^3/_2$ or $^5/_2$. (auth)

53201 LARGE ISOVECTOR MAGNETIC MOMENT FOR ROPER NUCLEON TRANSITION. Baacke, J.; Kleinert, H. (Freie Univ., Berlin). Lett. Nuovo Cim.; 2: No. 9, 463-7(28 Aug 1971).

It is shown that a saturation of the dispersion integrals by the lowest-lying baryons N,N(1470), and Δ(1240) yields the large value 1.2 ± 0.2 for the isovector anomalous magnetic moment K^v_{NR}. The accuracy of the approximation is demonstrated by calculating also K^v_{NN}; for completeness a prediction on K^v_{RR} is given. (L.B.S.)

53202 NONCHIRAL BREAKING FOR CHIRAL $SU_3 \times SU_3$? Gensini, P. (Univ., Lecce, Italy). Lett. Nuovo Cim.; 2: No. 9, 443-9(28 Aug 1971).

Some results concerning the nature of SU(3) × SU(3) chiral-symmetry breaking are discussed in light of a recent determination of the π-N σ-term. (L.B.S.)

53203 CONTRIBUTIONS OF SPIN-J BARYON POLES TO $\pi N \rightarrow \pi N$ AND $\pi N \rightarrow \gamma N$ AMPLITUDES. Arif-Uz-Zaman (International Atomic Energy Agency, Trieste, Italy). J. Math. Phys. (N. Y.); 12: No. 7, 1286-95(Jul 1971).

Contributions of baryon poles of spin J to the $\pi N \rightarrow \pi N$ and $\pi N \rightarrow \gamma N$ amplitudes were calculated using the Wigner–Bargmann formalism. An ambiguity arising from off-the-mass-shell continuation of the propagator was discussed and a continuation which gives pure spin-J behavior of the propagator for timelike propagator momentum was given. Moreover, it was shown that the parts of the amplitudes (with timelike propagator momentum) containing the highest power of the cosine of the scattering angle are free of this ambiguity. (auth)

53204 AMPLITUDE ANALYSIS OF πN SCATTERING AT 6 GeV/c. Halzen, F.; Michael, C. (CERN, Geneva). Phys. Lett.; 36B: No. 4, 367-70(20 Sep 1971).

The moduli and relative phases of the πN scattering amplitudes are extracted directly from 6 GeV/c data. The resulting amplitude structure at the cross-over and at $t = -0.6$ GeV^2 is analyzed and compared with high-energy models. The helicity structure of the $I_t = 0$ component is determined and predictions for R parameter measurements are given. (auth)

53205 EXCHANGE-DEGENERATE SCHEME FOR BARYONIC REGGE POLES IN CONNECTION WITH QUARK-LINE DIAGRAMS. Yoshida, Toshihiro (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1837-48(Jun 1971).

The exchange-degenerate solutions for the constraints, which come from the requirement of duality and the absence of exotic resonances, on the couplings of baryonic Regge-poles are investigated in connection with quark-line diagrams. Diagrams of H-type correspond to the solutions, whereas those of Z-type should disappear in the fully exchange-degenerate scheme. It is also shown that factorization holds among H-type diagrams for the systems of octet meson and octet, decuplet or singlet baryons. Classification of meson-baryon duality relations in terms of the diagrams is also discussed. (auth)

53206 ABSORPTION REGGE CUT IN πN BACKWARD SCATTERING. Okamura, Hiroshi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1889-1902(Jun 1971).

πN backward scattering data above 5 GeV/c are analyzed in terms of the baryon Regge pole exchange and accompanying Regge cut due to the strong absorption. The fit of the cross sections is reasonable. The role of the cut turns out to be very important: (1) The extrapolated magnitude of the Δ_δ residue at $\alpha_\Delta = ^3/_2$ is significantly larger than that without the cut. Δ_δ residue with or without the wrong signature sense zero at $\alpha_\Delta = ^1/_2$ is equally probable. (2) Prediction of polarization in $\pi^+p \rightarrow p\pi^+$ is quite different

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from that without the cut. Moreover, large polarization in $\pi^- p \rightarrow p\pi^-$ is expected. (auth)

53207 VENEZIANO DUALITY IN SU(3)-SYMMETRIC MESON–BARYON SCATTERING. Inami, Takeo (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1903-34(Jun 1971).

An SU(3) symmetric Veneziano model for pseudoscalar meson-baryon scattering is constructed. The model incorporates the full content of the exchange degeneracy pattern of baryon spectrum. A hypothesis is made that the leading trajectories bootstrap themselves as long as it is consistent with the crossing relation, no ghosts on the leading trajectories and certain physical requirements. If we further adopt a subsidiary hypothesis on the SU(3) structures of the daughter states, the A amplitude (we use CGLN's notation) is completely determined to within a scale factor. Possible SU(3) splitting of the trajectories is considered. Theoretical prediction for threshold values of A amplitudes agrees quantitatively with experimental values (which are given in terms of the s-wave and p-wave scattering lengths) for πN and KN scattering. It is shown that in the limit of quantized intercepts, the present model satisfies Adler's condition approximately. When applied to high-energy forward scattering, the model predicts the t-dependence of the F/D ratios of vector and tensor meson couplings. The theoretical value of the A amplitude associated with the non-strange vector and tensor Regge pole exchange agrees with the empirical value within a factor of two. (auth)

53208 LINEARLY RISING REGGE TRAJECTORIES AND STRONG MASS SPLITTING OF BARYONS. Katsumori, Hiroshi (Chubu Inst. of Tech., Nagoya, Japan). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1988-90(Jun 1971).

It is shown that the observed strong mass splitting of the baryon octet can be reproduced independently of the usual Okubo–Gell-Mann mass formula. The argument is essentially based on the Coleman–Glashow electromagnetic mass relation and the assumption that the Veneziano-like form factors with linearly rising Regge trajectories have a common asymptotic behavior over the octet members. (L.B.S.)

53209 BOUNDS ON POLARIZATION IN πN SCATTERING FROM ISOTOPIC SPIN INVARIANCE. Dass, G. V.; Froyland, J.; Halzen, F.; (and others) (CERN, Geneva). Phys. Lett.; 36B: No. 4, 339-42(20 Sep 1971).

Isotopic spin bounds on the polarization in $\pi^- p \rightarrow \pi^0 n$ scattering in terms of the polarizations in $\pi^+ p \rightarrow \pi^+ p$ and $\pi^- p \rightarrow \pi^- p$ scattering and the unpolarized differential cross sections for $\pi^+ p \rightarrow \pi^+ p$, $\pi^- p \rightarrow \pi^- p$, and $\pi^- p \rightarrow \pi^0 n$ scattering are derived, and compared with recent experimental data. Similar bounds on the P, R and A parameters for elastic scattering are also given. (auth)

53210 COMPLEX REGGE TRAJECTORIES AND THE RESONANT FIELD BOUNDARY. Potupa, A. S. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 5, 120-2(1970). (In Russian).

In the model of Regge trajectories with $\mathrm{Re}\alpha(s) = a + bs$ and $d/ds(\mathrm{Im}\alpha(s) > 0$ ($s > s_{th}$, where s_{th} is the threshold) s_B, the boundary of separation of the individual resonances ($\mathrm{Im}\alpha(s_B) = 2$) exists, where the half-width coincides with the average distance between resonances. An estimate for the baryon trajectories Δ_δ and N_γ gives the boundary $\sqrt{U_B} \simeq 4$ GeV. For resonances with $M_{res} \gg \sqrt{U_1} \simeq 2.8$ GeV ($\mathrm{Im}\alpha(s) = 1$) the determination of the spin is, in principle, hindered. The results are basically well conformed to the experimental situation. (tr-auth)

53211 SCALING FOR HADRONIC FORM FACTORS. Elitzur, Moshe (Rockefeller Univ., New York). Contract AT(30-1)-4204. Phys. Rev. Lett.; 27: No. 13, 895-8(27 Sep 1971).

Combining the Chou–Yang idea with the scaling property of inelastic electron scattering experiments, a scaling law is derived for the form factors of the hadronic transitions $N \rightarrow N^*$ in diffractive scattering. The agreement with experiment is very good. (auth)

53212 BROKEN SU(6) PREDICTIONS FOR BARYON PRODUCTION WITH POLARIZED VECTOR MESONS. Hirsch, E.; Karshon, U.; Lipkin, H. J. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Lett.; 36B: No. 4, 385-8(20 Sep 1971).

Quark model and SU(6) predictions for branching ratios of Λ, Σ and Y^* (1385) production in strangeness exchange reactions disagree with experiment. New predictions for vector meson polarization density matrix elements are presented which seem to agree with experiment. A "broken SU(6)" description which includes configuration mixing in the Σ and Y^* wave functions is consistent with the success of the polarization predictions and the failure of the branching ratio predictions of unbroken SU(6). (auth)

53213 LINE-REVERSAL-SYMMETRY BREAKING AND INTERFERENCE EFFECTS BETWEEN RESONANCES ON A DALITZ PLOT. Berger, E. L. (Argonne National Lab., Ill.); Fox, G. Phys. Lett.; 36B: No. 4, 389-93(20 Sep 1971).

General implications of duality for 2 → 3 particle reactions are discussed. It is shown explicitly that dual five-point amplitudes predict asymptotic violation of the usual equality of differential cross sections for quasi-two-body processes related by line-reversal. For example, an exchange degenerate model predicts $\lim_{s\rightarrow\infty} \sigma(\pi^+ p \rightarrow K^+\Sigma^+)/\sigma(K^- p \rightarrow \pi^-\Sigma^+) = 1$ but $\lim_{s\rightarrow\infty} \sigma(\pi^+ p \rightarrow K^+ Y^{*+})/\sigma(K^- p \rightarrow \pi^- Y^{*+}) \neq 1$. This effect arises from interference between competing two-body channels in the final state. (auth)

53214 ANALYSIS OF NUCLEAR INTERACTIONS BY THE MAXIMUM-MOMENTUM METHOD. Boos, E. G.; Nurpeisov, B.; Takibaev, Zh. S. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 4, 73-80(Jul-Aug 1970). (In Russian).

Four-pronged $\pi^- p$ interactions with a known number of particles in the final state are analyzed by the maximum-momentum method for momenta of 10 GeV/c. Angular and momentum distributions for baryon exchange are given. It is shown that, in charge exchange dominated by π^- mesons, for the case of charge exchange with protons significantly greater four-momentum is carried off when the baryon exchange is represented by a single neutron. Pions, which emerge in the backward hemisphere in the laboratory system, basically are coupled to baryon resonances. The amount of asymmetry in the pion angular distribution conforms with the two-body interaction model. The cross sections for the formation of the isobars $\Delta(1236)$, ρ mesons, and A1, A2, and g^- resonances are evaluated. (tr-auth)

53215 UNITARITY CONSTRAINTS ON HELICITY FLIP AMPLITUDES IN MESON–NUCLEON SCATTERING. Muetter, K. H. (CERN, Geneva). Nucl. Phys.; B31: No. 2, 589-601 (1971).

From direct channel unitarity bounds on the s-channel helicity flip amplitude are derived in terms of the non-flip amplitude. The conventional Regge pole parametrizations lead to values of the helicity flip amplitudes, which are rather close to these bounds. (auth)

53216 INEQUALITIES FOR THE PION–NUCLEON PARTIAL WAVES. Balachandran, A. P. (Syracuse Univ., N. Y. Istituto Nazionale di Fisica Nucleare, Naples); Case, W.; Della Selva, A.; Saito, S. Nucl. Phys.; B31: No. 2, 570-4(1971).

Two inequalities are derived for the pion–nucleon partial waves with angular momenta $l \leq 4$. (auth)

53217 DETERMINATION OF THE $\pi\Sigma\Sigma$ COUPLING AND A POSSIBLE $I = 2$ $\Sigma\pi$-RESONANCE. Engels, J.; Pilkuhn, H. (Institut fuer Theoretische Kernphysik, Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys.; B31: No. 2, 531-50(1971).

The value $(G^2_{\Sigma\Sigma\pi}/4\pi = 12.5 \pm 2.0$ is determined from forward and backward superconvergence relations in $\pi^-\Sigma^+ \rightarrow \pi^+\Sigma^-$ scattering. A $P_{3/2}$ $\pi\Sigma$ resonance of isospin 2, mass ~1600 MeV and width ~250 MeV is found from the Adler consistency condition for $\pi\Sigma$ scattering and low-energy dynamical models of pion–hyperon scattering. (auth)

53218 DYNAMICAL MODEL FOR THE πN-RESONANCES $S_{31}(1650)$, $S_{11}(1700)$ AND $D_{33}(1670)$. Gustafson, G. (NORDITA, Copenhagen). Nucl. Phys.; B31: No. 2, 461-76(1971).

A dispersion theoretic model is developed which explains the resonances $S_{31}(1650)$, $S_{11}(1700)$, and $D_{33}(1670)$ as ρN bound states caused by strong attraction in the ρN system due to σ-exchange. The coupling to the πN system is dominated by π-exchange. (auth)

53219 ABSORPTION EFFECTS DESCRIBED BY A COMPLEX PAIR OF REGGE POLES IN THE REACTION $\pi^+ p \rightarrow \pi^0 \Delta^{++}$. Butera, P. (Univ., Milan, Istituto Nazionale di Fisica Nucleare, Milan); Enriotti, M.; Marchesini, G. Nucl. Phys.; B31: No. 2, 455-60 (1971).

Absorption effects in the reaction $\pi^+ p \rightarrow \pi^0 \Delta^{++}$ are described by a complex-conjugate pair of Regge poles. A good fit is obtained for both the differential cross section and the Δ spin density matrix elements. (auth)

53220 TWO-PION EXCHANGE CONTRIBUTION TO MESON–NUCLEON SCATTERING IN THE LOW AND INTERMEDIATE ENERGY REGION. Alcock, J. W.; Cottingham, W. N. (Univ. of Bristol, Eng.). Nucl. Phys.; B31: No. 2, 443-54(1971).

The pion–nucleon and kaon–nucleon partial wave amplitudes with large angular momenta are estimated using the Mandelstam representation. (auth)

53221 SOFT-POINT PCAC SCATTERING LENGTHS AND SCALE INVARIANCE. Morris, Hedley C.; Thompson, Graham D. (University Coll., London). Nucl. Phys.; B31: No. 2, 283-300 (1971).

Within the framework of formal field theory, a more general approach to the problem of the extrapolation of the S-matrix off-mass-shell than is provided by normal PCAC is discussed. If the conventional PCAC hypothesis is used, in conjunction with the Gell–Mann, Oakes and Renner symmetry breaking model, within the pseudoscalar meson octet it predicts the relation $f_\pi = f_K = f_\eta$ which is badly violated experimentally. This approach eliminates this discrepancy and provides the prime equation for the determination of the $K^\pm p$ and πN scattering lengths which are the best to date. The value of the parameter m_0 predicted, which is the contribution to the average mass of the baryon octet due to SU(3) ⊗ SU(3) symmetry breaking, is very different from that which von Hipple and Kim find, and is of great importance in exploring the scale properties of the hadronic Hamiltonian. (auth)

53222 NEW VACUUM TRAJECTORY FOR PION–NUCLEON SCATTERING. Sundermeyer, Kurt (Univ., Hamburg). Nucl. Phys.; B31: No. 2, 369-80(1971).

It is shown that the asymptotic behavior of the isospin-zero part $A^{(+)}$ of the invariant amplitude A in πN scattering is determined by a vacuum trajectory with $\alpha(0) = -0.47 \pm 0.17$. With duality arguments and continuous-moment sum rules the assumption that s-channel helicity is conserved in πN scattering is confirmed. Because of the smallness of the trajectory, the influence of strong contributions of Δ(1236) and possible complications by wrong-signature nonsense points the slope cannot be satisfactorily determined. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 53292.

53223 (CONF-701002–, pp 27-41) NEUTRON–PROTON INTERACTION BELOW 30 MeV. Wilson, Richard (Harvard Univ., Cambridge, Mass.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The low-energy n-p experiments, which determine the singlet and triplet scattering lengths and effective ranges, are summarized in a 1970 recommended set of data. The P phase is also needed to obtain the n-p correction at 180°, a quantity used in reactor measurements. It is recommended that this P phase be obtained from models that give a smooth transition to the high-energy data. (auth)

53224 (DESY–71/34) RELATIVISTIC ONE-BOSON-EXCHANGE MODEL OF NUCLEON–NUCLEON INTERACTION. Schierholz, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1971. 26p. Dep. NTIS (U. S. Sales Only).

A relativistic one-boson-exchange model due to the exchange of the π, η, ϵ, ρ and ω mesons and an effective σ is presented for the elastic nucleon–nucleon (NN) interaction. The model is based on relativistic quantum mechanics as formulated previously. The potential is calculated from the off-shell field theoretical Born terms corresponding to the forementioned mesons. In order to avoid divergences form factors are introduced. For the vector-meson exchanges they are assumed to have Regge asymptotic behavior. The fictitious σ is fitted to the uncorrelated $\pi\pi$ S-wave contribution calculated by Durso which is to a great extent given by diagrams with an intermediate isobar. The remaining constants are adjusted to the NN phase shifts and to the binding energy of the deuteron. The model fits the phase shifts fairly well and accounts for the deuteron parameters. The obtained coupling constants are compared to the values found by other investigations. (auth)

53225 (FRNC-TH-51) APPLICATION OF THE OPTICAL MODEL TO π-NUCLEUS SCATTERING IN THE REGION OF THE $(^3/_2,{}^3/_2)$ RESONANCE. Schmit, Charles (Paris Univ., Orsay (France). Faculte des Sciences). 1971. 80p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The multiple scattering theory of Watson and the hypotheses that it implies are briefly reviewed; two simple models derived from them are studied: the Kisslinger model and the Glauber theory; the approximations introduced into the two models are compared. The pion-nucleus optical potential in the region of the $(^3/_2,{}^3/_2)$ resonance is calculated. A description of the nucleus, which allows the problem of pion-nucleus scattering to be studied as a three body problem, is given; the free pion-nucleon scattering matrix, and the effects of nucleon-nucleon interaction on the pion-nucleon scattering matrix in the nuclear material are studied. Calculations of the optical potential of the 1st and 2nd order are presented together with the numerical methods used. The results obtained are compared and discussed. (France)

53226 (LA-DC–12944) PRODUCTION OF $\pi^\pm$ MESONS BY 730-MeV PROTONS INCIDENT ON VARIOUS NUCLEI. Nagle, D.; Cochran, D. R. F.; Dean, P.; Gram, P.; Knapp, E.; Martin, E. R.; Perkins, R.; Shlaer, W.; Thiessen, H. A.; Theriot, D. (Los Alamos Scientific Lab., N. Mex.). 1971. 5p. (CONF-710911-6). Dep. NTIS.

From fourth international conference on high energy physics and nuclear structure; Dubna, USSR (7 Sep 1971).

Measurements of π^+ and π^- production by 730-MeV protons incident on nuclei were carried out. Eleven angles and twelve pion energies were used for the targets of hydrogen, deuterium, beryllium, carbon, aluminum, titanium, copper, silver, tantalum, lead, and thorium. The low-energy hydrogen data, the π^+ and π^- curves and total cross sections are given for the listed nuclei. (J.F.P.)

53227 (ORNL-tr–2502) FURTHER DEVELOPMENT OF THE INTRANUCLEAR CASCADE MODEL. Barashenkov, V. S.; Iljinov, A. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Oak Ridge National Lab., Tenn.), from report JINR–P2-5280. 8p. Dep. NTIS.

A model is suggested taking into account the local change of the intranuclear matter density as the cascade develops. The calculation results agree well with experiment up to $T \approx 30$ GeV; the multiparticle interaction contribution in this region turns out to be unessential. (auth)

53228 POISSON DISTRIBUTION OF SECONDARY PARTICLES IN STRAIGHT-LINE PATHS. APPROXIMATION IN QUANTUM FIELD THEORY. Barbashov, B. (CNRS, Marseille); Kuleshov, S.; Matveev, V.; Pervushin, V.; Sissakian, A. Nuovo Cim.; 4A: No. 4, 731-42(21 Aug 1971).

The problem of multiple production of "soft" mesons in high-energy two-nucleon collision is considered in the framework of standard quantum field theory models. The straight-line-path approximation is used to obtain the Poisson distribution of the secondary-particle number and to investigate the average particle number as a function of the choice of the cut-off parameters for momenta of the secondary particles in various asymptotic regions. (auth)

53229 MASS DEPENDENCE IN INCLUSIVE REACTIONS: TRI-REGGE BEHAVIOR. Pancheri-Srivastava, G. (Radcliffe Inst., Cambridge, Mass.); Srivastava, Y. Lett. Nuovo Cim.; 2: No. 8, 381-4(21 Aug 1971).

An analysis is made of experimental data on $p + p \rightarrow c + X$ interactions, where $c = \pi^+, \pi^-, K^+, K^-, p$, and $\bar{p}$, at 19.2 GeV/c in search for evidences for tri-Regge behavior. The spectrum for each particle is discussed separately. Reasonable support is found for the mass dependence as obtained from the triple Reggeon graph. (L.B.S.)

53230 PRODUCTION OF INTERMEDIATE BOSONS IN STRONG INTERACTIONS. Lederman, L. M.; Pope, B. G. (Columbia Univ., New York). Phys. Rev. Lett.; 27: No. 11, 765-8(13 Sep 1971).

From data on muon pairs and by use of the hypotheses of conservation of vector current and scale invariance, the cross section for production of weak vector mesons $W^\pm$ is estimated at energies pertinent to Brookhaven National Laboratory, the CERN intersecting storage rings, and the National Accelerator Laboratory. With existing data, these estimates imply a lower limit of 4.5 GeV/c^2 for the $W^\pm$ mass. (auth)

53231 CHARACTER OF HIGH ENERGY PARTICLE SCATTERING AT LARGE MOMENTUM TRANSFERS. Arushanov, G. G. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz.; 13: No. 6, 1309-13(Jun 1971). (In Russian).

Elastic scattering corresponding to the modified overlapping function is investigated. It is shown that there are three essentially different regimes for the differential cross section outside the diffraction cone, according to a parameter c ($c < 1$, $c = 1$, $c > 1$). Experimental data on the pp scattering inside the diffraction cone as well as outside it are reasonably described by the $c > 1$ regime. (auth)

53232 MULTICHANNEL CALCULATIONS OF HYPERON–NUCLEON CROSS-SECTIONS AND PHASE SHIFTS. Letessier, J.; Tounsi, A. (Institut de Physique Nucleaire, Paris). Nuovo Cim.; 5A: No. 1, 56-81(1 Sep 1971).

The hyperon–nucleon cross sections are computed by taking into account the coupling between the ΛN and ΣN channels. For this purpose a multichannel ND^{-1} method is used within the framework of the one-boson exchange model. The number of coupling constants needed is reduced by symmetry arguments and the free parameters left are fixed by fitting the ΛN cross-section data. Good fits are obtained and the predictions of the model concerning the ΣN cross sections are in good agreement with the experimental data. Furthermore a hyperon–nucleon phase-shift analysis is performed. No indication of a resonance is found; the Λp cross section enhancement attributed sometimes to a $^3S_1$ Λp resonance seems to be accounted for by the coupling effect between ΛN and ΣN channels. (auth)

53233 COUPLED-CHANNEL EFFECTIVE-RANGE ANALYSIS OF HYPERON–NUCLEON INTERACTIONS. Letessier, J.; Tounsi, A. (Institut de Physique Nucleaire, Paris). Nuovo Cim.; 5A: No. 1, 82-9(1 Sep 1971).

Scattering lengths and effective ranges of low-energy hyperon–nucleon scattering are computed from completely determined amplitudes obtained in a multichannel ND^{-1} formalism within the framework of the one-boson exchange model. Comparison is made with results of different models based on coupled Schrödinger equations with various potentials and good agreement with scattering and hypernuclei data is observed. (auth)

53234 HELICITY-FLIP PROPERTY OF THE A_2NN COUPLING. Kleinert, H. (Freie Univ., Berlin); Weisz, P. H. Lett. Nuovo Cim.; 2: No. 9, 459-62(28 Aug 1971).

It is shown that the technique of subtracting forward and backward dispersion relations from each other at threshold provides a powerful tool for the determination of on-shell coupling constants of particles exchanged in the t-channel. In particular, the coupling of the A_2-meson on-shell predominantly to the helicity-flip amplitude is demonstrated. (L.B.S.)

53235 LOW-ENERGY PROTON–PROTON SCATTERING AS A TEST OF LOCAL HIDDEN-VARIABLE THEORY. Fox, R. (Technion-Israel Inst. of Tech., Haifa). Lett. Nuovo Cim.; 2: No. 11, 565-7(11 Sep 1971).

It is suggested that a high-intensity low-energy (1 to 4 MeV) proton beam scattered from a proton-containing target, each of the two emitted protons entering a polarization analyzer containing helium gas, can be used to test local hidden-variable theory. It is shown that the predicted results of quantum mechanics and hidden-variable theory differ greatly. (L.B.S.)

53236 ASYMPTOTIC pp ELASTIC SCATTERING. Barger, V. (Univ. of Wisconsin, Madison); Geer, K.; Phillips, R. J. N. Phys. Lett.; 36B: No. 4, 343-6(20 Sep 1971).

Implications of the new CERN ISR data are analyzed. The importance of possible curvature in the Pomeron trajectory and the logarithm of the Pomeron residue are noted. Various hypotheses are surveyed and compared, namely (1) flat Pomeron (2) curved P trajectory (3) curved P residue (4) P with constructive cuts (5) P with destructive cuts. (auth)

53237 EXTRAPOLATION OF THE pp DIFFRACTION SLOPE TO INFINITY. Barger, V. (Univ. of Wisconsin, Madison); Geer, K.; Phillips, R. J. N. Phys. Lett.; 36B: No. 4, 350-2(20 Sep 1971).

The new ISR measurements of the pp elastic slope parameter b deviate markedly from the logarithmic extrapolation $b = b_0 + 2\alpha'_P \ln s$ through the Serpukhov data. It is observed that an empirical extrapolation rule $b = b_0 + b_1 s^{-1/4}$ successfully correlates all the existing data at small $|t|$. This rule can be derived as a consequence of interference between a non-shrinking Pomeranchuk term and the usual secondary Regge exchanges. An "effective" Regge pole model fit to the data is given. (auth)

53238 QUANTIZATION OF SECONDARY ENERGY AND MULTIPLE FIRE-BALL PRODUCTION. Shen, Ming-liang (Tusculum Coll., Greeneville, Tenn. Oak Ridge National Lab., Tenn.). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1817-26(Jun 1971).

A phenomenological model is presented of multiple particle production characterized by the quantization of secondary energy found in the analysis of cosmic-ray jets. Within the framework of the model, the predictions agree satisfactorily with all available experimental data. They are briefly mentioned or outlined. The explanation of all experimental features pertaining to fire-ball production is displayed in detail, as an example, to show how the model works quantitatively. (auth)

53239 PION PRODUCTION AND BOUND NUCLEI. Ingram, C. H. Q. (Oxford Univ.); Tanner, N. W.; Domingo, J. J.; Rohlin, J. Nucl. Phys.; B31: No. 2, 331-48(1971).

Cross sections for reactions of the type $pA \to (A + 1)\pi^+$, where A and (A + 1) are bound nuclei, are expressed in terms of the cross section for the reaction $pp \to d\pi^+$ and a form factor, through an approximation originally due to Ruderman. The formula successfully accounts for the energy dependence of bound state pion production and, roughly, for the magnitude of the cross sections. (auth)

Particle Invariance Principles and Symmetries

53240 CROSS SECTION FOR $^{11}B(p,2p)^{10}Be$ AT 150 AND 600 MeV: IMPLICATIONS FOR COSMIC-RAY STUDIES. Raisbeck, G. M.; Yiou, F. (CNRS, Orsay, France). Phys. Rev. Lett.; 27: No. 13, 875-7(27 Sep 1971).

The cross section for $^{11}B(p,2p)^{10}Be$ was measured to be 19 ± 6 and 25 ± 8 mb at 150 and 600 MeV, respectively. These values show that the tertiary production of ^{10}Be in cosmic rays is very important. However, it still appears likely that an actual isotope abundance measurement in cosmic rays will be necessary to utilize this nuclide as a cosmic-ray "clock". (auth)

General

Refer also to abstracts 53314, 53375, and 53830.

53241 (AD–720854) PROPOSED TEST OF THE CONSERVATION OF CHARGE CONJUGATION IN POSITRONIUM DECAY. Mani, H. S.; Rich, Arthur (Michigan Univ., Ann Arbor. Dept. of Physics). Mar 1971. 24p. (AFOSR-TR–71-736). NTIS.

If the electromagnetic interactions conserve charge conjugation, C, then singlet positronium (Ps) can only decay into an even number of photons, while triplet Ps can only decay into an odd number. One considers a model Hamiltonian which violates C but conserves parity. (auth) (USGRDR)

53242 (NYO–4204-16) PERTURBATION THEORY ABOUT A GOLDSTONE SYMMETRY. Li, Ling-fong; Pagels, Heinz (Rockefeller Univ., New York). [1970]. Contract AT(30-1)-4204. 11p. Dep. NTIS.

It is shown that if a Hamiltonian symmetry is realized by Goldstone bosons then, in general, one does not expect the S-matrix and matrix elements of currents to be analytic functions of the symmetry breaking parameters. This modifies the nonrenormalization theorems for vector form factors and some previous theorems. (auth)

53243 DYNAMICAL SYMMETRY OF NONSTATIONARY SYSTEMS. Malkin, I. A.; Man'ko, V. I.; Trifonov, D. A. (Lebedev Inst. of Physics, Moscow). Nuovo Cim.; 4A: No. 4, 773-92(21 Aug 1971).

The problem of the symmetry of equations and that of the dynamical symmetry of nonstationary quantum systems are discussed and some particular cases are considered. It is shown that the dynamical symmetry group is the same both for stationary and nonstationary systems. The dynamical symmetry group for any N-dimensional quantum system with a quadratic Hamiltonian is obtained as the $U_{N,1}$ group. For the systems which are stationary in the remote past and future the transition amplitudes between initial and final states may be regarded as matrix elements of representations of groups. In the general case of a quadratic Hamiltonian this group is the group of motion of the N-dimensional non-Euclidean complex space. In greater detail, a charged-particle motion in a uniform time-dependent electromagnetic field, an N-dimensional generalized oscillator and a three-dimensional charged oscillator in electromagnetic field are considered. (auth)

53244 ΔI = 1 PARITY VIOLATING FORCE. Berovic, N. (Univ. of Birmingham, Eng.). Phys. Lett.; 35B: No. 6, 475-6 (5 Jul 1971).

It is found that the vector analyzing power of certain reactions can be used to measure the parity-violating force and its isospin character. (auth)

53245 REMARKS ON THE BREAKING OF DILATION INVARIANCE. Bose, S. K.; McGlinn, W. D. (Univ. of Notre Dame, Ind.). Phys. Rev., D; 4: No. 2, 342-4(15 Jul 1971).

Some formal implications of broken scale invariance are derived. (auth)

53246 ALLOWED DOMAINS IN THEORIES OF BROKEN CHIRAL SYMMETRY. Carruthers, P.; Haymaker, Richard W. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 4: No. 2, 406-11(15 Jul 1971).

Theories are considered in which the explicit breaking of the chiral symmetry $SU_3 \times SU_3$ of the energy density Θ_{00} is of the form $\epsilon_0 u_0 + \epsilon_8 u_8$, where ϵ_0, ϵ_8 are real constants and u_0 and u_8 are scalar densities in the representation $(3,\bar{3}) + (\bar{3},3)$. An extension of this picture is proposed, in which the $SU_3 \times SU_3$-invariant part of Θ_{00} has the form $\bar{\Theta}_{00} + \epsilon_9 u_9$, where $\bar{\Theta}_{00}$ is $U_3 \times U_3$ invariant and the $SU_3 \times SU_3$-invariant scalar u_9 breaks $U_3 \times U_3$ in a specific way. Specifically, it is assumed that the ninth axial charge F_9^5 transforms u_9 into a pseudoscalar v_9 according to $i[F_9^5,u_9] = \kappa v_9$, where $i[F_9^5,v_9] = -\kappa u_9$. (The parameter k labels the representation.) Given this group structure, the analysis of Okubo and Mathur may be extended to find allowed domains for the symmetry-breaking parameters ϵ_0, ϵ_8, ϵ_9 and the vacuum expectation values $\langle u_0 \rangle$, $\langle u_8 \rangle$, and $\langle u_9 \rangle$. The positivity conditions now restrict $\langle u_9 \rangle$ so that the allowed domains occupy certain volumes in a three-dimensional space. (auth)

53247 ABOUT ONE CLASS OF REPRESENTATIONS OF THE LIE ALGEBRA. Havlicek, M. (Charles Univ., Prague). Commun. Math. Phys.; 20: No. 2, 130-42(1971).

Let R(G) be the skewsymmetric representation of the algebra G characterized by the following main property: if $G' \subset G$ is some subalgebra of G (possible noncompact) then R(G′) is integrable and reducible in the direct sum of irreducible representations of subalgebra G′. The development of the elementary theory of the described representations is described culminating in the proof of one version of Schur's lemma. (auth)

53248 WIGNER–ECKART THEOREM FOR LOCALLY COMPACT GROUPS. Klimyk, A. U. (Inst. of Theoretical Physics, Kiev). Teor. Mat. Fiz.; 8: No. 1, 55-60(Jul 1971). (In Russian).

Wigner–Eckart theorem for the matrix elements of a tensor operator transformed according to the unitary irreducible representation of locally compact (noncompact) group is proved. (auth)

53249 RELATIVISTIC EQUATIONS OF MOTION WITHOUT REDUNDANT COMPONENTS. Fushchich, V. I.; Grishchenko, A. L.; Nikitin, A. G. (Inst. of Mathematics, Moscow). Teor. Mat. Fiz.; 8: No. 2, 192-205(Aug 1971). (In Russian).

On the basis of a definite representation for the generators of the proper Poincaré group all the operator functions H (up to unitary equivalence) which the equation is invariant under the total Poincaré group (including space–time reflections) are described. For the case of arbitrary spin, the unitary operator connecting the representation with the canonical Foldy–Shirokov representation is found. The explicit forms of the coordinate, velocity and spin operators are obtained in the representation for arbitrary spin. (auth)

53250 PROJECTION OPERATORS FOR SIMPLE LIE GROUPS. Asherova, R. M.; Smirnov, Yu. F.; Tolstoi, V. N. (Moscow State Univ.). Teor. Mat. Fiz.; 8: No. 2, 255-71(Aug 1971). (In Russian).

The solution of many problems in nuclear theory and elementary particle physics amounts to decomposing the reducible representations of the symmetry groups of quantum mechanical systems into irreducible components. To carry out this decomposition, projection operators are needed. For all simple compact Lie groups G(l) of the rank l (both classical and exceptional), operators which project the arbitrary vector with the weight $f = (f_1, f_2, \ldots, f_l)$ onto the highest weight vector of the irreducible representation $D^{[f]}$ of the group G(l) were constructed. The projection operators are represented in the form of series composed of powers of the infinitesimal operators, which makes them convenient for the solution of particular problems concerning the decomposition of reducible representations into irreducible components. The structure of the projection operators is given for all simple compact Lie groups by similar formulas. (auth)

53251 PLANCHEREL MEASURE OF THE PRINCIPAL CONTINUOUS SERIES OF UNITARY REPRESENTATIONS OF THE GROUP U(p,q). Leznov, A. N.; Savel'ev, M. V. (Inst. of High-Energy Physics, Serpukhov, USSR). Teor. Mat. Fiz.; 8: No. 2, 161-74(Aug 1971). (In Russian).

The explicit expression is obtained for the Plancherel measure of the principal continuous series of unitary representations of the group U(p,q). (auth)

53252 C, P, AND T IN c-NUMBER INFINITE COMPONENT WAVE FUNCTION. Naka, Sigefumi; Goto, Tetsuo (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1979-86(Jun 1971).

The C-conjugation in the infinite component wave function is studied from the kinematical point of view. An explicit form of C-conjugation on canonical basis is given in the case of the unitary representation of the proper Lorentz group. As a simple application, it is shown that two bilinear invariants $\phi^+\phi$ and $\phi_c^+\phi$ exist. Properties of simple wave equations under C, P and T are studied and it is shown that the C invariance of the wave equation implies the existence of positive and negative energy solutions. (auth)

53253 POINCARE-IRREDUCIBLE TENSOR OPERATORS FOR POSITIVE-MASS ONE-PARTICLE STATES. I. Steiger, Arno D. (Univ. of California, Livermore). J. Math. Phys. (N. Y.); 12: No. 7, 1178-91(Jul 1971).

The main objective is the relativistic generalization of the ordinary SO(3)-irreducible spin tensor operators for particles with positive mass. Two classes of relativistic one-particle tensor operators are constructed. The tensor operators of the first class transform according to those representations of the Poincaré group that are induced by the one-valued unitary irreducible representations of the pseudo-unitary group SU(1,1) which belong to the continuous principal and the discrete principal series. These tensors are operator-valued functions of a spacelike 4-momentum transfer. The tensor operators of the second class correspond to vanishing 4-momentum transfer. They transform according to those representations of the Poincaré group that are induced by the unitary irreducible representations of the pseudo-orthogonal group SO(3,1) or its universal covering group SL(2C) which belong to the principal series. Both classes of Poincaré-irreducible tensor operators are constructed in a spin-helicity basis for timelike 4-momentum by means of projection operators which are continuous linear superpositions of unitary operator realizations for the groups SU(1,1) and SL(2C). The Clebsch–Gordan coefficients associated with the reduction into the two classes of Poincaré-irreducible tensor operators of a dyadic product of spin-helicity basis vectors are calculated. (auth)

53254 CONFORMAL GROUP IN A POINCARE BASIS. I. PRINCIPAL CONTINUOUS SERIES. Macfadyen, N. W. (Cambridge Univ., Eng.). J. Math. Phys. (N. Y.); 12: No. 7, 1436-45(Jul 1971).

In work on the global representation theory of SU(2,2), with particular emphasis on the Poincaré subgroup, the two principal continuous series of unitary irreducible representations are studied. These are defined by operators on Hilbert spaces of functions over a six-dimensional manifold, and after an automorphism of the group by a real orthogonal transformation [in precise analogy to that used in the mapping $SU(1,1) \rightarrow SL(2,R)$] these are displayed in such a form that the Poincaré subgroup $SL(2,C) \times T_4$ appears in a simple fashion. The generators of translations, dilations, Lorentz and special conformal transformations are given as differential operators, and by using these explicit expressions for the eigenvalues of the three Casimir operators of the group are found. Finally, the reduction of the two series when restricted to the Poincaré group is performed. It is found that all those principal series representations of ¶ enter which allow a certain value of the helicity. (auth)

53255 NOTE ON THE NEW SYMMETRY OF THE RACAH COEFFICIENTS. Yakimiw, E. (Univ. of Montreal). J. Math. Phys. (N. Y.); 12: No. 7, 1134(Jul 1971).

It is shown that the "new symmetry" of Racah coefficients, recently derived [J. Math. Phys. 11, 3061(1970)] does not exist. (auth)

53256 REMARK ON MINTON'S SYMMETRY FOR RACAH FUNCTIONS. Joshi, Vinaya (Duke Univ., Durham, N. C.). J. Math. Phys. (N. Y.); 12: No. 7, 1134-6(Jul 1971).

It is shown that the symmetry relation for Racah coefficients recently given previously holds only for an analytical continuation of the Racah coefficients to unphysical angular momenta, and even then is valid only under unrealistically stringent conditions. (auth)

53257 SU(3) SYMMETRY AND STATISTICAL MODEL FOR MULTIPLE PARTICLE PRODUCTION. Maltsev, V. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; B31: No. 2, 278-82(1971).

A simple method of parametrization of the SU(3) group is suggested. The projection of a physical state, containing an arbitrary number of octets and decuplets is represented by an integral over the parameter space of the symmetry group. (auth)

53258 HOMOTOPICAL SIGNIFICANCE OF THE TYPE OF VON NEUMANN ALGEBRA FACTORS. Araki, Huzihiro (Kyoto Univ.); Smith, Mi-soo Bae; Smith, Larry. Commun. Math. Phys.; 22: No. 1, 71-88(1971).

The set of all projections and the set of all unitaries in a von Neumann algebra factor A are studied from the homotopical point of view relative to the operator norm topology. Two projections E and F can be deformed continuously to each other if and only if $E \sim F$ and $1 - E \sim 1 - F$ where ~ denotes the equivalence of projections in A in the sense of von Neumann. In other words, the relative dimension and co-dimension are complete homotopical invariants of projections in A and label pathwise connected components of the set of projections. The first homotopy group $\pi_1(U(A))$ of unitaries in A is shown to be 0 for A of infinite type. For type II_1 and type I_n factors, $\pi_1(U(A))$ are isomorphic to additive groups of reals R and integers Z, respectively, in which the first homotopy group $\pi_1(LU(A))$ of the center of U(A) is imbedded as Z and nZ, respectively. (auth)

53259 UNIT ADJOINT TENSOR OPERATORS IN SO(n). Wong, M. K. F. (Fairfield Univ., Conn.). J. Math. Phys. (N. Y.); 12: No. 8, 1530-5(Aug 1971).

Unit adjoint tensor operators in SO(n) were obtained, and the eigenvalues of the invariants connected with them evaluated. These adjoint tensor operators are keys to the solution of the multiplicity problem of the Wigner coefficients of SO(n). These adjoint tensor

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operators are used in the calculation of the Wigner coefficients of SO(5) in the direct product of the 10-dimensional representation with an arbitrary representation. The results agree with previous work. (auth)

53260 POINCARE-IRREDUCIBLE TENSOR OPERATORS FOR POSITIVE MASS ONE-PARTICLE STATES. II. Steiger, Arno D. (Univ. of California, Livermore). J. Math. Phys. (N. Y.); 12: No. 8, 1497-1507(Aug 1971).

Relations are studied between the two classes of Poincaré-irreducible tensor operators which were constructed in a previous paper. The tensor operators of the first class transform according to those representations of the Poincaré group that are induced by the one-valued irreducible unitary representations of SU(1,1) which belong to the continuous and the discrete principal series. The tensor operators of the second class transform according to the Poincaré group representations that are induced by the irreducible unitary principal series representations of SL(2,C). The Poincaré-irreducible tensor operators of the second class are decomposed into Lorentz-irreducible tensor operators which transform by the irreducible unitary SL(2,C) representations of the principal series. The expansions of a spin density matrix describing a statistical ensemble of wavepackets into Poincaré- and Lorentz-irreducible components are derived. The infinite-dimensional associative algebra for the Poincaré-irreducible tensor operators of the second class is constructed. No such algebra exists for the Poincaré-irreducible tensor operators of the first class. The operator product of these tensors can only be represented as a linear superposition of the first class tensors in the limit of vanishing 4-momentum. In this limit, however, the first class tensors are no longer irreducible. (auth)

53261 MATRIX ELEMENTS FOR THE MOST DEGENERATE CONTINUOUS PRINCIPAL SERIES OF REPRESENTATIONS OF SO(p,1). Boyer, Charles P. (Pennsylvania State Univ., University Park). J. Math. Phys. (N. Y.); 12: No. 8, 1599-1603 (Aug 1971).

The matrix elements for finite group transformations of the most degenerate continuous principal series of unitary irreducible representations of SO(p,1) are calculated. They are shown to agree with special cases already known. (auth)

53262 MODIFICATION RULES AND PRODUCTS OF IRREDUCIBLE REPRESENTATIONS OF THE UNITARY, ORTHOGONAL, AND SYMPLECTIC GROUPS. King, R. C. (Univ. of Southampton, Eng.). J. Math. Phys. (N. Y.); 12: No. 8, 1588-98(Aug 1971).

Modification rules, expressible in terms of the removal of continuous boundary hooks, are derived which relate nonstandard irreducible representations (IR's) of the unitary, orthogonal, and symplectic groups in n dimensions to standard IR's. Tensorial methods are used to derive procedures for reducing the outer products of IR's of U(n), O(n), and Sp(n) and for reducing general IR's of U(n) specified by composite Young tableaux with respect to the subgroups O(n) and Sp(n). In these derivations the conjugacy relation between the orthogonal and the symplectic groups is fully exploited. The results taken in conjunction with the modification rules are valid for all n. (auth)

53263 RELATIVISTIC WAVE EQUATIONS: PROPER LORENTZ INVARIANCE AND INVARIANCE UNDER DISCRETE TRANSFORMATIONS. Seetharaman, M.; Jayaraman, J.; Mathews, P. M. (Univ. of Madras). J. Math. Phys. (N. Y.); 12: No. 8, 1620-2(Aug 1971).

Considering the standard form $i\partial\psi/\partial t = H\psi$ [with ψ transforming according to $D(0,s) \oplus D(s,0)$] of wave equations for free particles of arbitrary spin, the admissible forms of H consistent with invariance of the equation under the Poincaré group and under T, C, and P were recently determined. It is shown that even if T and C invariance is not imposed, the admissible Hamiltonians are the same (apart from one extra possibility H = E). Expressed differently, except for the trivial case H = E, invariance of free-particle equations under the connected Poincaré group and P implies T and C also. (auth)

53264 COUPLING OF DE SITTER SPACE-TIME AND INTERNAL SYMMETRY. Tait, W.; Cornwell, J. F. (Univ. of St. Andrews, Fife, Scotland). J. Math. Phys. (N. Y.); 12: No. 8, 1651-4(Aug 1971).

Via Levi's radial splitting theorem for Lie algebras, all possible unifications of the de Sitter algebras with a real, simple, internal symmetry algebra are found. (auth)

53265 EULER FACTORIZATION OF SO(p,q) AND SU(p,q) GROUPS. Maduemezia, Awele (International Centre for Theoretical Physics, Trieste, Italy). J. Math. Phys. (N. Y.); 12: No. 8, 1681-5(Aug 1971).

A parametrization scheme for orthogonal and unitary groups is developed. This scheme is broadly similar to one developed earlier by Wigner, but differs from it in some essential details. It is shown that an arbitrary element g of the group SO(p,q), [SU(p,q)], $3 \leq p < \infty$, $0 \leq q < \infty$, $p + q = N$, can be written as a product of three factors, g = aBc, such that the extreme factors a and c belong to SO(p,q − 1) [SU(p,q − 1)] and the middle factor is an element of SO(p,q), [SU(p,q)] depending on at most two parameters and representing a "rotation" (real, complex, unitary or pseudo-unitary, as the case may be) in the (1 − N) plane. This parametrization includes the Euler parametrization $R = R_{12}(\varphi_1) R_{13}(\theta)R_{12}(\varphi_2)$ of the group SO(3) as a special case, and is therefore a generalization of the Euler angle concept to more general orthogonal and unitary groups. The present factorization scheme differs from Wigner's, which is of the form $g = [SO(p) \otimes SO(q)] K[SO(p) \otimes SO(q)]$ [and similarly for SU(p,q)], in that the extremal factors of this latter scheme are not the next natural subgroup of the original group. Consequently, the middle term K may depend on more than two parameters. Furthermore, the method of proof presented is entirely different from Wigner's, and may serve as a useful alternative, if further generalization to real Lie groups that preserve some other types of bilinear forms is envisaged. By stepwise factorization, the element g may ultimately be expressed as a product of real, complex, unitary or pseudo-unitary "rotations" in the plane. (auth)

53266 POLYNOMIAL BASES FOR REPRESENTATIONS OF SEMISIMPLE LIE ALGEBRAS. Devi, V. Syamala (Andhra Univ., Waltair, India). J. Math. Phys. (N. Y.); 12: No. 8, 1732-4 (Aug 1971).

It is shown that the polynomial bases for representations of a semisimple Lie algebra are just the various terms of typical concomitants of the Lie algebra. Consequently, the construction of polynomial bases reduces to a problem in the theory of invariants. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 53102.

53267 SCALING LAWS, LIGHT CONE BEHAVIOR, AND HARMONIC ANALYSIS ON SL_{2C}. Ferrara, S. (CERN, Frascati, Italy); Rossi, G. Nuovo Cim.; 4A: No. 4, 851-65(21 Aug 1971).

The electroproduction structure functions, defined on a suitable homogeneous space with respect to the spinor group $SL_{2,C}$, are subjected to harmonic analysis. In this way the Bjorken limit and the scaling law can be recovered by simple assumptions and a sum rule is obtained. The connection of this analysis with a generalized light-cone expansion is derived. (auth)

53268 NONLOCAL SYMMETRY OPERATIONS, THE CABIBBO ANGLE, AND THE LEPTONIC DECAYS OF VECTOR MESONS. Woo, Ch. H. (Univ. of Maryland, College Park). Phys. Rev., D: 4: No. 2, 393-7(15 Jul 1971).

Symmetries which are not exact but which leave the vacuum invariant cannot be implemented locally. Simple nonlocal symmetries are considered. For the in- and out-fields, the nonlocality involved can be simply some trivial transformations that accompany the internal-symmetry index transformations. In particular, with proper relative normalizations, a set of in-fields $\hat{\phi}_\alpha^{in}(0)$ will transform irreducibly under the nonlocal group. If one assumes that the vector currents $V_\alpha^\mu(0)$ behave like vector-meson fields $\Box\hat{\phi}_{\alpha,in}^\mu(0)$, as far as the vacuum to one-vector-meson matrix elements are concerned, one finds $\tan\theta_Y = \tan\theta_B(m_\phi/m_\omega)^2$ and $\frac{1}{3}\, m_\rho\Gamma(\rho \to ee) = m_\omega\Gamma(\omega \to ee) + m_\phi\Gamma(\phi \to ee)$, both previously derived from Weinberg's first sum rule. If one assumes that the weak axial-vector currents behave like the pseudoscalar meson fields $\partial_\mu\hat{\phi}_\alpha^{in}(0)$, as far as the vacuum to one-pseudoscalar-meson matrix elements are concerned, one finds $m_\pi/m_K = (f_K/f_\pi)\tan\theta_A$. (auth)

53269 SYMMETRY BREAKING OF THE CHIRAL U(3) ⊗ U(3) AND THE QUARK MODEL. Kobayashi, Makoto; (Nagoya Univ., Japan). Kondo, Hiroki; Maskawa, Toshihide. Progr. Theor. Phys. (Kyoto); 45: No. 6, 1955-9(Jun 1971).

Through an analysis of the masses of η and X mesons, possible symmetry breaking terms are introduced, in addition to the quark mass term, and are explicitly constructed from quark fields. The six-fermion interaction is discussed as one of their simplest examples. (auth)

53270 RELEVANCE OF THE MASS-SPLITTING THEOREMS. Cornwell, J. F. (Univ. of St. Andrews, Fife, Scotland). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1987-88(Jun 1971).

It is shown that Mirman's objections to the relevance of the mass splitting theorems which are concerned with the embedding of the Poincaré group and an internal symmetry group in a large Lie group may be overcome without difficulty, and that the mass splitting theorems do relate to the physical situation. (L.B.S.)

Applications (Strong)

53271 GENERAL BOSON STATES OF U_n x U_n AND Sp_4 x Sp_4. Holman III, W. I. (Middle East Tech. Univ., Ankara. Inst. for Theoretical Physics, Kiev). Nuovo Cim.; 4A: No. 4, 904-31 (21 Aug 1971).

A recursive construction of the boson states of U_n x U_n is established in terms of reduced matrix elements of totally symmetric tensor operators. The Weyl coefficients of the U_n groups are given explicitly in terms of U_{n-1} Racah coefficients. Alternative expressions for the SU_3 x SU_3 state are obtained. The structure of the general Sp_4 x Sp_4 state is discussed, and errors in a previous report on this state are corrected. (auth)

53272 PARTIAL CONSERVATION OF AXIAL-VECTOR CURRENT IN A NONLINEAR CONFORMAL AND CHIRAL LAGRANGIAN MODEL. Turner, Leaf (Univ. of Toronto). Phys. Rev., D; 4: No. 2, 398-400(15 Jul 1971).

It is shown that all Lagrangian functions of scalar fields yielding conformally invariant actions may be expressed in covariant derivative notation. The nonlinear pion Lagrangian is studied and both the chiral and conformal symmetry with partial conservation of axial-vector current are broken. If smoothness of the $\sigma\pi\pi$ amplitude is required, it is found that the axial-vector current divergence and the pion field have unit scale dimension. (auth)

Field Theories

General

53273 RADIATION REACTION AS A RETARDED SELF-INTERACTION. Teitelboim, Claudio (Princeton Univ., N. J.). Phys. Rev., D; 4: No. 2, 345-7(15 Jul 1971).

It is shown that the exact Lorentz–Dirac equation of motion for a strictly point charge is nothing more than the usual Lorentz force law when the retarded self-field of the particle is properly taken into account, as required for the very consistency of the idea of energy-momentum localization in the field. (auth)

53274 LAWS OF CONSERVATION OF SCALAR ELECTRODYNAMICS WITHIN THE FORMALISM OF A UNIFIED FIELD. Kuvshinov, V. I.; Fedorov, F. I. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 1, 83-9(1971). (In Russian).

The Lagrangian for a unified field was investigated in which the pertinent variables included wave functions of a scalar particle, antiparticles, a Maxwellian field, and symmetrical and antisymmetrical matrices. Using this Lagrangian, the laws of conservation of energy-momentum, the moment of momentum, and current, for a unified field, and finally charge conjugation were examined. (tr-auth)

53275 NONSTATIC AXIALLY SYMMETRIC SPACE–TIME. Roy, S. R.; Tripathi, V. N. (Banaras Hindu Univ., India). Gen. Relativity Gravitation; 2: No. 2, 121-7(1971).

The general nonstatic axially symmetric line element was considered in the context of Petrov classification. The space–time is found to be of various Petrov types under different circumstances. The necessary algebraic conditions for such a space–time to be of class one were also derived. It is found that there exists only one solution representing a plane symmetric class-one null-electromagnetic field. (auth)

53276 DUAL CHARGED PARTICLES IN ELECTRODYNAMICS. Strazhev, V. I. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 6, 122-4(1970). (In Russian).

The consequences of the equivalence of the electrodynamics of electrically and magnetically charged particles with the condition of the universality of the relation g/e to the electrodynamics of the particle, which possesses one effective charge, $q = (e^2 + g^2)^{1/2}$, are considered. (tr-auth)

53277 NOTE ON THE ELECTRODYNAMICS OF ACCELERATED SYSTEMS. Post, E. J.; Bahulikar, D. D. J. Math. Phys. (N. Y.); 12: No. 7, 1098-9(Jul 1971).

Some preliminary results concerning the experimental testability of the free-space constitutive relations are discussed in connection with some recent theoretical developments. (auth)

53278 SIMPLIFIED INTRINSIC PROOF OF THE RAINICH DIFFERENTIAL RELATION. Luehr, C. P. (Univ. of Florida, Gainesville); Rosenbaum, M. J. Math. Phys. (N. Y.); 12: No. 7, 1113-15(Jul 1971).

The necessity and sufficiency of the Rainich differential relation, a basic equation of the "already unified field theory," is proved in a simplified way by intrinsic techniques. Some tensor identities of interest in their own right are derived and used in this proof. The results generalize those given in a previous paper, where only the necessity of the Rainich differential condition was proved. (auth)

53279 GEOMETRIZATION OF A MASSLESS COMPLEX SCALAR FIELD. Ludwig, Garry (Univ. of Alberta, Edmonton). J. Math. Phys. (N. Y.); 12: No. 7, 1218-19(Jul 1971).

The necessary and sufficient conditions that a Riemannian geometry has as its source a massless complex scalar field are presented. (auth)

53280 GEOMETRIZATION OF A MASSIVE SCALAR FIELD. Ludwig, Garry (Univ. of Alberta, Edmonton). J. Math. Phys. (N. Y.); 12: No. 7, 1220-1(Jul 1971).

The necessary and sufficient conditions that a Riemannian geometry has as its source a real or complex massive scalar field are presented. (auth)

Quantum Field Theory

Refer also to abstracts 52979, 53004, 53049, 53176, and 53245.

53281 (IC–71/75) QUASIPOTENTIAL APPROACH TO THE TWO-BODY PROBLEM IN QUANTUM FIELD THEORY. Todorov, I. T. (International Centre for Theoretical Physics, Trieste (Italy)). Aug 1971. 29p. (CONF-700714–2). Dep. NTIS (U. S. Sales Only).

From International School of Subnuclear Physics Seminar; Trapani, Italy (1 Jul 1970).

A relativistic Lippmann–Schwinger type equation for the elastic scattering amplitude T is derived from the following general requirements: The equation must be consistent with the on-mass-shell Feynman perturbation expansion of T. For a hermitian potential ($V = V^*$) it should imply elastic unitarity for all energies. When the mass of one of the particles tends to infinity it has to go into the conventional relativistic (Klein-Gordon or Dirac) equation in an external field for the other particle. The (energy-dependent) potential V may be split, in general, into a sum of a local and an exchanged local part. It is given by an infinite power series in the coupling constant(s) which fits the on-shell perturbation expansion of T. Keeping only the lowest order term in V, the relativistic eikonal formula for T, which is a good approximation for small exchanged mass and momentum transfer, is derived. In the case of quantum electrodynamics an effective 4-potential V_μ is introduced in the place of the single scalar function V. Defining V_μ with an $e^2/4\pi(=\alpha)$ accuracy from the Born diagram for T a relativistic Balmer formula which includes fine-structure splitting and recc effects and is accurate up to order α^4 is obtained. (auth)

53282 RENORMALIZED AXIAL DIVERGENCE IN QUANTUM ELECTRODYNAMICS. Mason, A. L. (Univ. of Cambridge, Eng.). Nuovo Cim.; 4A: No. 4, 749-64(21 Aug 1971).

Bogoliubov–Parasiuk–Hepp renormalization techniques are used to derive renormalized Ward identities for the axial vector divergence in quantum electrodynamics. The results of Adler and Bardeen and the independence of their results of the particular regularization employed are illustrated. (auth)

53283 QUANTUM FIELD THEORY MODELS. Glimm, James (New York Univ., N. Y.). pp 153-66 of Eighth Annual Eastern Theoretical Physics Conference Proceedings. /Rohrlich, F. (ed.). Syracuse, N. Y.; Syracuse Univ. (1969).

From eighth eastern theoretical physics conference; Syracuse, N. Y. (10 Oct 1969). See CONF-691033.

Recent progress in the qualitative or structural aspects of quantum field theory is reviewed. It is pointed out that the results show that many of the conventional ideas in field theory can be given a mathematically correct formulation in two dimensions. The results show that quantum fields can be obtained by a limiting process from more elementary objects such as the solutions of partial differential equations. (J.F.P.)

53284 FIELD THEORIES WITH INDEFINITE METRIC. Coleman, Sidney (Harvard Univ., Cambridge, Mass.). pp 197-216 of Eighth Annual Eastern Theoretical Physics Conference Proceedings. /Rohrlich, F. (ed.). Syracuse, N. Y.; Syracuse Univ. (1969).

From eighth eastern theoretical physics conference; Syracuse, N. Y. (10 Oct 1969). See CONF-691033.

The variant on conventional quantum electrodynamics is discussed. The formal structures of the theory and the acausal aspects are considered. Also some speculations on avoiding some apparent paradoxes in acausal theory are given. (J.F.P.)

53285 INFINITE SET OF QUASIPOTENTIAL EQUATIONS FROM THE KADYSHEVSKII EQUATION. Yaes, Robert J. (Univ. of Texas, Austin. Illinois Inst. of Tech., Chicago). Phys. Rev., D; 3: No. 12, 3086-90(15 Jun 1971).

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It is shown that by modifying the propagator in the Kadyshevsky equation, an infinite set of quasipotential equations can be obtained which satisfy both Lorentz covariance and elastic unitarity and of which the Logunov–Tavkhelidze–Blankenbecler–Sugar–Alessandrini–Omnes equation and the Gross equation are special cases. It is also shown that the perturbation scheme of Chen and Raman, for using the quasipotential equation to obtain approximations to the Bethe–Salpeter equation, can be greatly simplified by the use of resolvent-identity-type arguments. (auth)

53286 ABSENCE OF SECOND-ORDER CORRECTION TO THE TRIANGLE ANOMALY IN QUANTUM ELECTRODYNAMICS. **Young, B.-L. (Iowa State Univ., Ames); Wong, T. F.; Gounaris, G.; Brown, R. W. Phys. Rev., D; 4: No. 2, 348-53(15 Jul 1971).**

An investigation is made of possible ambiguities involved in calculating the second-order correction to the axial-vector anomaly. The testing ground is finite-mass quantum electrodynamics where the anomaly is defined using Pauli–Villars regularization. The result supports Adler's previous conclusion that there exist no such corrections. Furthermore, the mass renormalization is explicitly shown to be consistent in this order. (auth)

53287 ASYMPTOTIC ACTION PRINCIPLE. **Pugh, Robert E. (Univ. of Toronto). Phys. Rev., D; 4: No. 2, 353-9(15 Jul 1971).**

An action principle is derived from the unitarity of the S matrix. Assuming the usual asymptotic behavior of the renormalized interpolating fields, emission-absorption symmetry, and the Bose nature of the S operator, the connection between spin and statistics and the quantization of the asymptotic fields is obtained. It is essential to the proof that the system has a nontrivial interaction, but one does not assume the relativistic invariance of the interacting system. (auth)

53288 MASSIVE VECTOR MESON IN EXTERNAL FIELDS. **Minkowski, P. (Schweizerisches Instituet fuer Nuklearforschung, Zurich); Seiler, R. Phys. Rev., D; 4: No. 2, 359-66(15 Jul 1971).**

The propagation of classical and quantized vector fields under the influence of external fields constant over wide regions of space-time is investigated. Noncausal propagation is established for suitable external fields. The canonically quantized vector field generates a perturbation expansion for the propagation function which is in agreement with the behavior of the solutions for the classical vector field. (auth)

53289 FAILURE OF THE EIKONAL APPROXIMATION FOR THE VERTEX FUNCTION IN A BOSON FIELD THEORY. **Eichten, E.; Jackiw, R. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 2, 439-43(15 Jul 1971).**

By an explicit calculation of the high-energy behavior of the three-point function in the $\lambda\phi^3$ theory, through terms of order λ^5, it is demonstrated that the eikonal approximation for generalized ladder exchange fails in that model, for this vertex function. In a given order, it underestimates the exact asymptote. (auth)

53290 QUANTUM THEORY OF GRAVITATION AND THE MASS OF THE ELECTRON. **Rosen, Gerald (Drexel Univ., Philadelphia). Phys. Rev., D; 4: No. 2, 275-7(15 Jul 1971).**

Gravity-modified quantum electrodynamics formulated by Salam and collaborators is applied to the electron self-energy problem in all orders of perturbation theory. It is shown that the dressed physical mass of the electron is likely to be given by the formula $m = Me^{-x/\alpha}$, where $M \equiv (\hbar c/16\pi G)^{1/2}$ is the universal quantum-gravitational mass constant, $\alpha = (137.04)^{-1}$ is the fine-structure constant, and $x = (0.362)$ is a number to be computed from the details of the theory. (auth)

53291 HIGH-ENERGY ELASTIC AND INELASTIC SCATTERING IN φ^3 THEORY. Chang, Shau-jin (Univ. of Illinois, Urbana); Yan, Tung-mow. Phys. Rev., D; 4: No. 2, 537-8(15 Jul 1971).

High-energy elastic and inelastic processes are studied in a φ^3 theory based on the following model: For the elastic-scattering amplitude the leading terms in each order of perturbation of the t-channel straight ladders, plus those obtained by interchange of the Mandelstam variables s and u are summed. The s-channel iteration is then performed with the t-channel ladders as single units. Only the physical regions in which the incident particles retain their large momenta are considered. This procedure leads to the eikonalization of the t-channel ladders. For the inelastic production amplitude, the dominant contribution comes from diagrams with any number of totally open ladders (i.e., multiperipheral chains) modified by unopen ones. The main results are: (a) The total cross section approaches zero, approaches a constant, or increases as $(\ln s)^2$ according as the coupling constant is smaller than, equal to, or larger than a critical value. (b) Elastic and inelastic differential cross sections are computed, and they have many nice features, as suggested by the absorption model. (c) Nonforward s-channel unitarity is explicitly verified. (d) One-particle and multiparticle spectra, the average multiplicity, the number distribution of the final particles, etc., are obtained. The implications of these results to hadron physics are discussed. (auth)

53292 EIKONAL APPROXIMATION IN PSEUDOSCALAR THEORY. **Carlson, C. E. (Univ. of Chicago); Neff, T. L. Phys. Rev., D; 4: No. 2, 532-6(15 Jul 1971).**

In an effort to extend the semiclassical intuitions developed in infrared-dominated field theories (quantum electrodynamics, ϕ^3, etc.) to field theories more likely characteristic of strong interactions, the high-energy-small-momentum-transfer limit of the ordinary linearly coupled fermion-pseudoscalar (nucleon-pion) interaction is considered. In contrast with the infrared theories, (without using a cutoff) dominance of "hard" exchanged pions is found, but with a dynamically forced pair-wise correlation resulting in an s-dependent effective potential appearing in the eikonal phase. The correspondence of the nonfixed-pole "soft" two-pion structure thus developed to a nonlocal generalization of Wentzel-pair theory is made, and the qualifications on the quantum field theory necessary to produce this semiclassical picture are explored. The role played by internal structure such as spin, isospin, and chiral symmetry is particularly interesting. The asymptotic behavior of the theory is extracted and it is found that the dominant N–N amplitude is s-channel helicity nonflip. (auth)

53293 CANONICAL LIGHT-CONE COMMUTATORS. **Cornwall, John M.; Jackiw, R. (Univ. of California, Los Angeles). Phys. Rev., D; 4: No. 2, 367-78(15 Jul 1971).**

The canonical structure of current commutators on the light cone, as embodied in Kogut and Soper's formulation of quantum electrodynamics in the infinite-momentum frame, is studied. These commutators incorporate dynamical information far beyond that contained in conventional equal-time commutation relations. An analog of the Bjorken–Johnson–Low limit is developed for calculating matrix elements of light-cone commutators from conventional time-ordered products. Some apparently new sum rules for electroproduction are obtained. They relate Fourier transforms of structure functions to bilocal products of operators. Possible directions for constructing phenomenological light-cone commutators in hadronic physics are suggested. These commutators can be used to describe entire Regge trajectories, and might find application to electroproduction and neutrino-induced production experiments. (auth)

53294 FEYNMAN RULES FOR THE YANG–MILLS FIELD: A CANONICAL QUANTIZATION APPROACH. I. **Mohapatra, Rabindra Nath (State Univ. of New York, Stony Brook). Phys. Rev., D; 4: No. 2, 378-92(15 Jul 1971).**

An attempt has been made to derive covariant Feynman rules for the massless Yang–Mills field, starting with canonical methods of quantization. The techniques involved in such a program, along with a few preliminary results, are summarized. Working in the radiation gauge ($\partial_i b_i = 0$), we find that there is an infinity of noncovariant vertices. A noncovariant set of rules are obtained to describe them to any order. Working with the suggested set of rules, it is first proved that all tree diagrams can be described by a covariant set of Feynman rules. Secondly, to order g^2, it is found that the one-loop diagram can also be made covariant. However, apart from the usual three-vector and four-vector vertices, the covariant loop contains an extra vertex of vector-scalar-scalar type and the scalar loop occurs with a weight factor of –2 with respect to the vector loop. (auth)

53295 ASYMPTOTIC BEHAVIOR OF THE VERTEX FUNCTION IN QUANTUM ELECTRODYNAMICS. **Fishbane, Paul M.; Sullivan, J. D. (Univ. of Illinois, Urbana). Phys. Rev., D; 4: No. 2, 458-75(15 Jul 1971).**

Using recently developed infinite-momentum techniques, the asymptotic behavior of the three-point function in quantum electrodynamics (massive photons) is studied by summing the leading behavior of the perturbation series. It is found that the leading diagrams are those in which photons are exchanged in all permutations across the external photon insertion. When the fermion lines are on-shell, an earlier speculation of Jackiw is confirmed based on a fourth-order calculation, namely, that the vertex exponentiates in the form $\bar{u}(p_f)\Lambda^\mu u(p_i) = \bar{u}(p_f)\gamma_\perp u(p_i)e^{-\Phi}$, where $\Phi = (e^2/16\pi^2)\ln^2(Q^2/\mu^2)$. In a fashion which is reminiscent of eikonalization in a scattering process, Φ is characteristic of single-photon exchange across the vertex. An $O(e^4)$ contribution to Φ coming from vacuum polarization is identified and computed. The concept of infinite-momentum pathways and the possibility of exponentiation in scalar theories are discussed. (auth)

53296 QED TEST BY LARGE ANGLE BHABHA SCATTERING. **Augustin, J. E.; Buon, J.; Delcourt, B.; (and others) (Ecole**

Normale Superieure, Orsay, France). pp II58-65 of Ve Rencontre de Moriond sur les Interactions Electromagnetiques. Orsay, France; Laboratoire de Physique Theorique et Hautes Energies (1970).

From fifth international conference on electromagnetic interactions; Meribel-les-Allues, France (9 Mar 1970). See CONF-700325.

Quantum electrodynamics (QED) was tested at large momentum transfers by a study of large-angle Bhabha scattering using the Orsay colliding beam ring. The rate of the double bremsstrahlung at small angles and the theoretical cross section of this reaction were used to measure the luminosity. The experimental value of the Bhabha scattering cross section was compared to the theoretical cross section and a lower limit of a cut off in QED was deduced. The measurement is chiefly a test of QED for spacelike virtual photons. (France)

53297 TOPOLOGICAL QUESTIONS IN THE CANONICAL FORMULATION OF GRAVITATION. **Deser, S. (Brandeis Univ., Waltham, Mass.). Gen. Relativity Gravitation; 2: No. 1, 23-6(1971).**

Exploratory questions are considered concerning the extent to which the world is a satisfactory starting point for classical and quantized general relativity viewed as a dynamical system, working from the framework of Lorentz invariant field theory, as understood in elementary particle physics, and proceeding with a discussion of Einstein theory within it. A new feature, relevant to gravitation, arising when differential constraints are present, is discussed. It is argued that in many ways the dynamics of the Einstein field can be dealt with in terms of normal flat space field theoretical concepts, and that complications characterised as topological from the geometric point of view will take care of themselves in the relations between dynamical and constraint variables. Topology may be only a quantitative rather than a qualitative complication so far as the dynamics of gravitation are concerned. (UK)

53298 SOMMERFELD-WILSON QUANTISATION OF THE METRIC FIELD. **Bergmann, P. G. (Syracuse Univ., N. Y.). Gen. Relativity and Gravitation; 2: No. 1, 37-42(1971).**

A reformulation of the Hamilton-Jacobi theory is discussed. It is considered that such a theory would not be very helpful if it required for its application the adoption of a highly restrictive set of coordinate conditions; nor would a formalism uniquely appropriate to general relativity but worthless in, for example, classical mechanics. The formalism presented avoids these difficulties; this formalism highlights, in an unexpected manner, topological aspects of Sommerfeld-Wilson quantization by means of phase integrals. Further exploration of this approach is recommended. (UK)

53299 CONVERGENCE OF THE APPROXIMATION METHOD IN THE GENERAL THEORY OF RELATIVITY. Ryabushko, A. P. **(Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 1, 90-9(1971). (In Russian).**

For a Schwarzschild field and the equation of motion of a light body in this field, there is demonstrated a convergence of the approximation method developed by the Einstein-Infeld and Fock-Papapeter school in the general theory of relativity for obtaining the metrics of Riemannian space, time and equation of motion of bodies of comparable mass. (tr-auth)

53300 SUPERPROPAGATOR OF FIELDS WITH EXPONENTIAL COUPLING. **Lehmann, H.; Pohlmeyer, K. (Univ., Hamburg). Commun. Math. Phys.; 20: No. 2, 101-10(1971).**

The vacuum expectation value of the time-ordered product of two exponentials of free fields is defined as a distribution using minimal singularity as a criterion. The implication of this definition for an exponentially self-coupled scalar field is studied in second order of a perturbation expansion. (auth)

53301 ANOMALOUS DIMENSIONS IN NONPERTURBATIVE SCALAR FIELD THEORY. **Bui-Duy, Q. (Univ. of Montreal). Lett. Nuovo Cim.; 2: No. 7, 321-5(14 Aug 1971).**

It is shown that the self-interacting scalar $\lambda\phi^4$ theory yields a scale-invariant two-point function in the ladder approximation. (L.B.S.)

53302 COMPOSITE AND ELEMENTARY PARTICLES WITH IDENTICAL QUANTUM NUMBERS IN QUANTUM FIELD THEORY. **Braun, M. A.; Izergin, A. G. (Leningrad State Univ.). Teor. Mat. Fiz.; 8: No. 1, 37-48(Jul 1971). (In Russian).**

The formal scheme of the theory describing N elementary particles with identical quantum numbers is developed. It is shown that the poles in the proper mass of the elementary particles are present, if the formation of composite particles with the same quantum numbers is possible. The equations are written which determine the parameters of the composite particle. The symmetry of these equations with respect to the permutation of the parameters of composite particle and any one of the elementary particles is discussed. However this symmetry does not in all cases mean the equivalence of the corresponding particles. The possibility of describing the composite particles as a certain special case of the elementary particles in another theory is investigated. Conditions of the nonelementarity are formulated which transform some M from N + M particles with the identical quantum numbers into composite particles. (auth)

53303 AXIOMATIC FIELD THEORY IN TERMS OF OPERATOR JACOBI MATRICES. **Berezanskii, Yu. M.; Koshmanenko, V. D. (Inst. of Mathematics, Moscow). Teor. Mat. Fiz.; 8: No. 2, 175-91(Aug 1971). (In Russian).**

It is proved that the Wightman axiomatic theory of the Hermitian scalar field can be reformulated in terms of operator Jacobi matrices, by the analogy with the transition to the Jacobi matrices in the problem of momenta. This reformulation leads in a natural way to the notion of quasifield, which is a simpler object than the field. Generating functionals being close to Wightman's functionals and defining the quasifield are studied. In the case of the free field the formulations of the theory in terms of Jacobi matrices and in terms of creation— annihilation operators coincide with each other. (auth)

53304 FERMION-BASED PARTICLE MODEL. **van der Spuy, E. (Atomic Energy Board, Pelindaba, South Africa).** Nuovo Cim.; 5A: **No. 1, 163-83(1 Sep 1971).**

A brief discussion is given of how a nonlinear field equation of motion in terms of a fundamental fermion field may be constructed and used as a model showing many features of elementary particles. Since the equation with $\psi(x)$ in the $(\frac{1}{2}, 0)$ representation is γ_5 invariant, it allows a weakly interacting solution, which is perturbative and massless to some approximation indicated and provides a model for leptons. The conditions for the latter solution permit g^2 to be determined: $-2\pi^2 g^2 = 1$ to the present approximation. Furthermore, it is suggested that a strictly nonperturbative solution may be constructed, which will be strongly interacting and may provide a model for hadrons. The fundamental infinite-component free field to be derived in the latter solution will carry a tower of fermions on a Regge trajectory. The γ_5 invariance does not apply to this solution due to ψ now being in terms of a sum of representations $(j^A = \frac{1}{2}, j^B)$ which may be analytically continued in j^B. Preliminary considerations indicate that M^2 is 2 to 3 times the nucleon mass squared. The equation of motion is Lorentz and C, P, T invariant with respect to both solutions. It is suggested that the photon, the electromagnetic interaction and strangeness may be introduced in a way following Heisenberg, by considering the isospin symmetry of the equation of motion to be broken by the vacuum or world state. It is suggested that g^2 is of the correct order to lead possibly to the well-known value of the fine-structure constant. Without the isospin symmetry breaking the Hilbert spaces of the lepton and hadron solutions are completely orthogonal. It is suggested that this isospin symmetry breaking causes a certain lack of orthogonality leading to a leakage corresponding to the weak decay. (auth)

53305 EQUAL-TIME CURRENT COMMUTATOR AND SUM RULES IN THE AXIOMATIC FIELD THEORY. Miranskii, V. A. **(Inst. of Theoretical Physics, Kiev). Teor. Mat. Fiz.; 8: No. 2, 215-25(Aug 1971). (In Russian).**

The equal-time commutator of currents in the axiomatic quantum field theory is considered. Using some previous theorems the number and the structure of Schwinger terms are determined, which depend on the asymptotical behavior at infinity of the Fourier transforms of the retarded functions. As a consequence, sufficient conditions for the validity of the Gell-Mann-Fubini sum rules are obtained. (auth)

53306 ENERGY MOMENTUM SPECTRUM AND VACUUM EXPECTATION VALUES IN QUANTUM FIELD THEORY. II. **Glimm, James (New York Univ., N. Y.); Jaffe, Arthur. Commun. Math. Phys.; 22: No. 1, 1-22(1971).**

It is proved that the $\mathscr{P}(\varphi)_2$ quantum field theory satisfies the spectral condition. The space time translation $a = (x, t)$ is implemented by the unitary group $U(a) = \exp(itH - ixP)$, and the joint spectrum of the energy operator H and the momentum operator P is contained in the forward cone. Bounds on certain vacuum expectation values of products of field operators are also obtained. The proofs involve an analysis of the limit $V \to \infty$ for approximate theories in a periodic box of volume V. Assuming the existence of a uniform mass gap, all the Wightman axioms are established with the exception of the Lorentz invariance of the vacuum. (auth)

53307 PERTURBATION OF PSEUDORESOLVENTS AND ANALYTICITY IN 1/c IN RELATIVISTIC QUANTUM MECHANICS.

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Veselic, K. (Rudjer Boskovic Inst., Zagreb. Univ., Zagreb). Commun. Math. Phys.; 22: No. 1, 27-43(1971).

The analytic functional calculus, relatively bounded and analytic perturbations of pseudoresolvents were studied. As an application, the nonrelativistic limit of the Dirac and Klein–Gordon operator in the presence of an external static field was considered. It was proved that the resolvents of these operators have only a removable singularity at $c = \infty$. This implies the analyticity at $c = \infty$ of the eigenvalues and eigenvectors corresponding to the bound states of the mentioned operators. (auth)

53308 SUMMATION VECTORS FOR A VON NEUMANN ALGEBRA. **Dixmier, J.; Marechal, O. (Univ., Paris). Commun. Math. Phys.; 22: No. 1, 44-50(1971). (In French).**

It is proved that the set of cyclic vectors for a von Neumann algebra in a Hilbert space H is a G_δ set, which is empty or dense. Some corollaries are obtained, for instance: if $(A_1, A_2, \ldots)$ is a sequence of von Neumann algebras in H, and if each A_n has a cyclic vector and a separating vector, then there exists a vector in H which is cyclic and separating for each A_n. For algebras of local observables, the known results connecting the infinite type of the algebras and the existence of cyclic and separating vectors are improved. (auth)

53309 QUANTUM STOCHASTIC PROCESSES. III. **Davies, E. B. (Mathematical Inst., Oxford). Commun. Math. Phys.; 22: No. 1, 51-70(1971).**

An example of a quantum stochastic process with a non-zero, linear, time-independent source, is constructed for a massive scalar boson field in four space–time dimensions. A similar process with only a single degree of freedom is also studied in detail. (auth)

53310 REGULARIZED NONPOLYNOMIAL LAGRANGIANS. **Bollini, C. G.; Giambiagi, J. J.; Vucetich, H. (Univ. Nacional, La Plata). Lett. Nuovo Cim.; 2: No. 10, 493-8(4 Sep 1971).**

A method is proposed to regularize directly the nonpolynomial Lagrangian in such a manner that ambiguous expressions are avoided and the resultant propagator is similar to those that appear in the analytic regularization method. (L.B.S.)

53311 CANONICAL FORMALISM AND SCHWINGER TERMS. **Bui-Duy, Q. (Univ. of Montreal). Lett. Nuovo Cim.; 2: No. 10, 515-18(4 Sep 1971).**

The problem arising in expressing the currents for the equal-time commutator in the canonical formalism is considered. It was proposed by Schwinger to define carefully the formally local currents by the split-point method. It is shown that, contrary to common belief, the vacuum expectation value of the formal current commutator is not zero, even though the formal currents are not split and the canonical formalism is used. (L.B.S.)

53312 THEORY OF PHOTONS AND ELECTRONS ON NULL PLANES. **Rohrlich, F. (Syracuse Univ., N. Y.). Acta Phys. Austr.; 32: No. 1, 87-106(1970).**

The usual description of quantum electrodynamics in which the physical system develops from one spacelike plane to the next is replaced by a new dynamics in which the development proceeds over null planes. The field theory is developed first classically and then as a quantum field theory in the Dirac picture (interaction representation) and in the Heisenberg picture. The apparent disadvantage of now having field equations which are nonlocal, is by far offset by the following advantages: The electron field is fully described by Ψ_v which involves only two of the four components of Ψ, and the photon field is described by A_j (j = 1, 2) which are only two of the four components of A_μ. The other components are expressible in terms of Ψ_v and A_j which are known to satisfy an irreducible algebra on the null planes. There is no gauge problem. The formulation is ideally suited for the use of current algebras, high energy limits, and for laser theory. The computation of S-matrix elements requires new Feynman rules. (auth)

53313 GENERALIZED FREE FIELDS AS CYCLIC REPRESENTATIONS OF THE CANONICAL COMMUTATION RELATIONS. **Streit, L. (Bell Telephone Labs., Murray Hill, N. J.). Acta Phys. Austr.; 32: No. 1, 107-12(1970).**

While a generalized free field will not form a cyclic canonical pair with its time derivative it is shown that the space–time smeared field does give rise to a cyclic representation of the canonical commutation relations. Various properties of generalized free fields follow immediately from this observation. (auth)

53314 COMMENT ON THE CONFORMAL INVARIANCE OF THE ZERO-MASS KLEIN–GORDON EQUATION. **Bracken, A. J. (Univ. of Adelaide). Lett. Nuovo Cim.; 2: No. 11, 574-6(11 Sep 1971).**

It is pointed out that, if $\phi^{(m,n)}(x)$ is a multicomponent wave function transforming according to the finite-dimensional representation (m,n) of $SL_{2,c}$, then the equation $\partial^2\phi/\partial x_\lambda \partial x^\lambda = 0$ is not conformed invariant unless one of m and n vanishes. It is emphasized that conformal-invariant wave equations appropriate to the description of discrete-spin massless particles can only be written down for wave functions transforming according to representations of the type (n,0) or (0,n). (L.B.S.)

53315 STATIC GRAVITATIONAL FIELDS. I. EIGHT THEOREMS. **Das, A. (Simon Fraser Univ., Burnaby, Can.). J. Math. Phys. (N. Y.); 12: No. 7, 1136-42(Jul 1971).**

In a fresh look on static gravitational fields in general relativity, eight new theorems have resulted. Also in the process of deriving theorems a new solution has emerged. In the first of these theorems an invariant necessary integral condition for the existence of a solution was derived. Physically this condition corresponds to the equilibrium of matter. In the second theorem a scalar condition was found which implies the flatness of the static gravitational universe. In the third theorem it was proved that there cannot occur any group of motion along "the lines of forces." In theorems 5 and 6, the questions of whether the spatial part of a static gravitational universe can be Einstein, projectively flat, or Stäckel are investigated. In the seventh theorem, the static gravitational field equations were reduced to the geometrized equations in a spatial universe. In the last theorem, all conformastat gravitational universes were found. One of these is the universe due to "an infinite plate," and this is a new solution. (auth)

53316 EXACT STATIONARY STATES IN $|\phi|^{2N}$ FIELD THEORIES. **Rosen, Gerald (Drexel Univ., Philadelphia). J. Math. Phys. (N. Y.); 12: No. 7, 1192-4(Jul 1971).**

Exact physical solutions to the Schrödinger stationary state equation are reported for local, relativistic, real scalar theories featuring an interaction energy density of the form $g|\phi|^{2N}$, where the coupling constant g is positive and the exponent N is a constant parameter (not necessarily an integer) greater than unity. No interaction or scattering between the field quanta is manifest in the multiparticle state solutions, implying that the real scalar theories are effectively linear in the absence of mass or coupling constant renormalization. (auth)

53317 SELF-ADJOINT OPERATORS IN INDEFINITE METRIC SPACES. **Dobson, Peter N. Jr. (Univ. of Hawaii, Honolulu). J. Math. Phys. (N. Y.); 12: No. 7, 1207-10(Jul 1971).**

Some properties of self-adjoint operators in indefinite metric spaces are explored, with emphasis on the problem of the completeness of the set of eigenvectors. For operators in spaces of finite dimension, some simple criteria are deduced regarding the existence of such a complete set. Implications of completeness of eigenvectors for operators in infinite-dimensional spaces are discussed, and some partial extensions of the results for finite dimensions given. (auth)

53318 QUADRATIC FERMION INTERACTION HAMILTONIAN. **Gidas, Basilis (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.); 12: No. 7, 1414-19(Jul 1971).**

The interaction Hamiltonian $\lambda \int : \overline{\psi}^{(0)}(x)\psi^{(0)}(x) : g(x) d^s x$, $g(x) \epsilon S(R^s)$ is studied. An ultraviolet cutoff is introduced. This cutoff is removed, and the limit $g \rightarrow 1$ in $S(R^s)$ is taken by working with the Heisenberg fields. The limiting fields are well defined on the Fock space associated with the bare mass m_0. In the limit new representation of the canonical anticommutation relations is obtained which is given by a (generalized) Bogoliubov transformation. The new representation is not always unitarily equivalent to the bare mass Fock representations. (auth)

53319 VACUUM EXPECTATION VALUES AS INDICATRICES OF MAXIMAL REGULARITY. **Pfaffelhuber, E. (Univ. of Wyoming, Laramie). J. Math. Phys. (N. Y.); 12: No. 7, 1359-69(Jul 1971).**

Matrix elements and propagators of renormalizable field theories are defined in terms of indicatrices of maximal regularity. The relation of the indicatrix approach with analytic regularization and with the subtraction formalism is established. It is shown that the indicatrix formalism gives rise to well-defined propagators and that the self-energy of a particle vanishes on the mass shell so that no mass renormalization is necessary. The renormalization constant Z_3 equals one without the theory becoming a free one. This implies that, within the frame of the indicatrix approach, convergence of the theory is assured and renormalization actually is superfluous. (auth)

53320 PROPAGATORS OF UNRENORMALIZABLE FIELDS. **Pfaffelhuber, E. (Univ. of Wyoming, Laramie). J. Math. Phys. (N. Y.); 12: No. 7, 1370-8(Jul 1971).**

A general definition of propagators of casual unrenormalizable

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fields corresponding to rapidly increasing spectral functions is given in terms of indicatrices. The order of growth of the propagators is determined in terms of that of the spectral functions. The high energy bound is rigorously proved and the indeterminacy of the propagators is shown to be concentrated at the origin of the light cone. Theorems are proved concerning the approximation of unrenormalizable propagators by renormalizable ones. (auth)

53321 METHOD OF QUANTIZATION FOR RELATIVISTIC FIELDS. Hammer, C. L.; Tucker, R. H. (Ames Lab., Iowa). J. Math. Phys. (N. Y.); 12: No. 7, 1327-33(Jul 1971).

A procedure for quantization is given which does not require the canonical formalism. Only the equation of motion for the field and the resulting conserved current are needed to derive all the necessary commutators or anticommutators, the operators which represent the physical observables, the reduction formulas, and vacuum expectation values for the particle fields. The formalism is sufficiently general so that it holds for fields, or a superposition of fields, of arbitrary mass and spin. (auth)

53322 EXPERIMENTAL TEST OF THE THEORY OF MUONIC ATOMS. Dixit, M. S. (Univ. of Chicago); Anderson, H. L.; Hargrove, C. K.; (and others). Phys. Rev. Lett.; 27: No. 13, 878-81(27 Sep 1971).

Muonic x rays were measured in the energy region 150 to 440 keV in nine elements with an absolute precision of 15 to 21 eV for transitions with small nuclear effects. Calculated transition energies were found to be consistently larger than those measured by an amount that varied from 15 ± 16 eV at 157 keV to 137 ± 22 eV at 438 keV. For these transitions, the principal correction to the Dirac energy is the vacuum polarization. The discrepancy, however, lies outside the expected validity of quantum-electrodynamic calculations and one is unable, at present, to offer an explanation for this effect. (auth)

53323 INFINITE COMPONENT WAVE FUNCTION AND SCATTERING AMPLITUDE. II. Goto, Tetsuo; Otokozawa, Jun; Obara, Takashi (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1967-78(Jun 1971).

The scattering amplitude of two infinite component fields is studied in the lowest order diagram. It is shown that, although the amplitude corresponding to the ordinary diagram gives us a Regge pole, a Regge pole cannot be obtained from the crossed diagram. (auth)

53324 FINITE LOCAL FIELD THEORY. Taguchi, Yukio; Yamamoto, Kunio (Univ. of Osaka Prefecture. Osaka Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1995-6(Jun 1971).

An attempt is made to prove that the primitive divergences in the π-N system, which should be removed in the covariant theory, can be eliminated by introducing the structure in the interaction term of the energy-momentum tensor $T\mu\nu$. In this theory the matrix element of any operator product becomes finite. (L.B.S.)

53325 ARBITRARY SPIN FIELDS:SPECTRAL REPRESENTATIONS FOR THE TWO-POINT FUNCTIONS, AND THE CONNECTION BETWEEN SPIN AND STATISTIC. Mathews, P. M.; Seetharaman, M. (Univ. of Madras). Nucl. Phys.; B31: No. 2, 551-69(1971).

Two-point Wightman functions of arbitrary finite component relativistic fields (which may in general be reducible under the homogeneous Lorentz group) are related to those involving auxiliary fields transforming according to representations of the type D(j,0), and explicit representations are obtained on the basis of the usual axioms. The construction does not require the choice of any special kind of basis for the physical states. Using the spectral representations and the weak local commutativity condition a general proof is given for the spin-statistics connection. Special problems which arise in the case of reducible fields are discussed. (auth)

53326 SPONTANEOUS BREAKDOWN IN QUANTUM ELECTRODYNAMICS. Ferrari, R.; Picasso, L. E. (Univ., Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy). Nucl. Phys.; B31: No. 2, 316-30(1971).

In the context of quantum electrodynamics the spontaneous breakdown of the symmetry associated to gauge transformations of the second kind, with gauge functions linear in the coordinates is discussed. It is shown that the photons (both physical and unphysical) can be considered as the Goldstone particles of this symmetry, and that the Ward identity and, in general, all soft-photon theorems, are dynamical consequences of the spontaneous breakdown of the symmetry considered. (auth)

53327 INVARIANT REGULARIZATION OF NON-LINEAR CHIRAL THEORIES. Slavnov, A. A. (Steklov Mathematical Inst., Moscow). Nucl. Phys.; B31: No. 2, 301-15(1971).

Invariant regularization of nonlinear chiral Lagrangians is constructed. The regularized theory satisfies charge algebra constraints, threshold theorems and is unitary at sufficiently small energies. So it may be used for the description of low energy π-meson scattering. (auth)

53328 ZERO-SLOPE LIMIT OF THE DUAL RESONANCE MODEL. Scherk, J. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B31: No. 2, 222-34(1971).

It is shown that in the zero-slope limit, the unitarized dual resonance model reduces to the ϕ^3 theory. (auth)

53329 VECTOR-SCALAR SECTOR SOLUTIONS TO THE SPINOR-SPINOR BETHE-SALPETER EQUATION. Nakanishi, Noboru (Brookhaven National Lab., Upton, N. Y.). J. Math. Phys. (N. Y.); 12: No. 8, 1578-82(Aug 1971).

A new method is proposed to discuss the exact J = 0 vector-scalar sector solutions to the equal-mass spinor-spinor Bethe-Salpeter equation for the massless-meson exchange ladder model at the vanishing total 4-momentum. Under the assumption that all solutions belonging to a discrete spectrum have a discrete spectral representation in the relative 4-momentum squared, it is proved that no discrete solutions other than the solution (in the vector-coupling case) found previously exist in any case of the scalar, pseudoscalar, and vector couplings. As for the case of the axial-vector coupling, it is shown that possible eigenvalues have to belong to one of three exponentially increasing sequences; but the existence of any solution other than Keam's one is quite unlikely. It is mathematically interesting that in the above analysis one encounters some Diophantine equations of the second degree. (auth)

53330 CANONICAL PERTURBATION THEORY FOR NONLINEAR QUANTUM OSCILLATORS AND FIELDS. Carhart, R. A. (Univ. of Illinois, Chicago). J. Math. Phys. (N. Y.); 12: No. 8, 1748-62(Aug 1971).

The method of successive canonical transformation is developed to study both the classical and quantum versions of a system of n weakly interacting nonlinear oscillators. The method reproduces the essential features of the solutions to those nonlinear differential equations. A general quartic polynomial in the oscillator coordinates is taken as the interaction Hamiltonian. After the canonical transformations to the desired order, the classical system is quantized, resulting in immediate identification of the raising and lowering operators for the perturbed eigenstates in the nonresonant case. In the resonant case (commensurable frequencies) the transformed operators lead to finite-dimensional subspaces within which eigenstates lie, and are obtained by matrix methods. In each case the Heisenberg equations for the operators are solved as fully as presently possible. A particular case of two quantum oscillators is studied in detail, both for the resonant and nonresonant cases. Finally, the method is generalized to the continuum and applied to the Lee model. The usual results for the lowest sector are obtained to second order: the physical V particle and the mass shift of the V. Instability of this particle is related to the occurrence of nonlinear resonance in the lowest-order "interaction." (auth)

53331 TENSOR AND SPINOR SPHERICAL HARMONICS AND THE SPIN-s HARMONICS $_sY_{lm}(\theta,\phi)$. Campbell, William B. (Univ. of Nebraska, Lincoln). J. Math. Phys. (N. Y.); 12: No. 8, 1763-70 (Aug 1971).

A set of cartesian tensor spherical harmonics is constructed from the previous spin weighted harmonics $_sY_{lm}(\theta,\phi)$. It is shown that these tensor harmonics are eigenfunctions of total angular momentum, z component of total angular momentum, total spin and radial component of spin. In particular, $-s$ may be thought of as a helicity for outgoing radiation. Tensor operators are introduced which lower and raise this helicity. They are shown to correspond to the operators ∂ and ∂ introduced previously. Because the $_sY_{lm}(\theta,\phi)$ can be defined for half-integer values of l, m, and s, a set of spinor spherical harmonics is also constructed which has properties paralleling those of the tensor harmonics. (auth)

Gravitation and General Relativity

Refer also to abstracts 52587, 52589, 53065, 53070, 53089, and 53090.

53332 QUANTIZATION OF GRAVITATION. Komar, Arthur (Yeshiva Univ., New York). pp 109-21 of Eighth Annual Eastern Theoretical Physics Conference Proceedings. /Rohrlich, F. (ed.). Syracuse, N. Y.; Syracuse Univ. (1969).

From eighth eastern theoretical physics conference; Syracuse, N. Y. (10 Oct 1969). See CONF-691033.

Some of the difficulties of principle in the construction of a quantum theory of gravitation and the progress made thus far

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are sketched, and a number of different approaches are outlined. The quantization program, asymptotic quantization, and the Hamilton–Jacobi theory are considered. (J.F.P.)

53333 RELATIVITY OF MOTION. **Schuecking, E. L.** (New York Univ., N. Y.). **pp 123-34 of Eighth Annual Eastern Theoretical Physics Conference Proceedings.** /Rohrlich, F. (ed.). Syracuse, N. Y.; Syracuse Univ. (1969).

From eighth eastern theoretical physics conference; Syracuse, N. Y. (10 Oct 1969). See CONF-691033.

The motion of the earth about the sun is discussed in general relativity theory. The rotation of the earth is also considered. (J.F.P.)

53334 MOTION OF PARTICLES IN EINSTEIN'S RELATIVISTIC FIELD THEORY. I. INTRODUCTION AND GENERAL THEORY. **Johnson, Coates R.** **(Univ. of Georgia, Athens).** **Phys. Rev., D; 4: No. 2, 295-317(15 Jul 1971).**

Particles are represented through singularities in the field—such particles being called ideal particles—the field equations of Einstein's theory of the nonsymmetric field (unified field theory) can be solved step by step with respect to the powers of a parameter which measures the "strength" of the singularities associated with each particle. In paper I the above-mentioned approximation procedure is developed and it is shown that ideal particles in an isolated region of space-time interact with each other as if each particle were acted on by a force which depends on the particle's kinematic and structural properties and on a certain external field in the neighborhood of the particle. The approximation procedure allows one to find, to any order of approximation desired, the equations of motion satisfied by each particle, the equations of change satisfied by those quantities which characterize the structure of each particle, and the field equations satisfied by the external field which acts on each particle. The equations are Lorentz-covariant in form. (auth)

53335 MOTION OF PARTICLES IN EINSTEIN'S RELATIVISTIC FIELD THEORY. II. APPLICATION OF GENERAL THEORY. **Johnson, Coates R.** **(Univ. of Georgia, Athens).** **Phys. Rev., D; 4: No. 2, 318-20(15 Jul 1971).**

The approximation procedure of paper I is applied to the case of certain simple ideal particles located in an isolated region of space-time and find the equations of motion satisfied by the ideal particles to certain low orders of approximation. The equations of change satisfied by those quantities which characterize the structure of the particles and the field equations satisfied by the external field which acts on each particle are found. It is found that there are simple ideal particles which, in a finite region of spacetime, interact with each other, to a good approximation, according to the laws of Maxwell–Lorentz electrodynamics. In a higher order of approximation an additional interaction among the particles is found, which can be looked upon as a Lorentz-covariant generalization of the interaction given by Newton's gravitational theory. (auth)

53336 GRAVITATIONAL FORM FACTORS OF PSEUDOSCALAR MESONS, STRESS-TENSOR-CURRENT COMMUTATION RELATIONS, AND DEVIATIONS FROM TENSOR- AND SCALAR-MESON DOMINANCE. **Raman, K.** **(Wesleyan Univ., Middletown, Conn.).** **Phys. Rev., D; 4: No. 2, 476-88(15 Jul 1971).**

The low-momentum-transfer behavior of the gravitational form factors of the pseudoscalar mesons is derived, starting with the model-independent equal-time commutation relations between the stress tensor and the axial-vector current. The results indicate significant deviations from tensor-meson pole dominance and scalar-meson pole dominance of the matrix elements of the traceless part and the trace, respectively, of the stress tensor. An expression is derived for the stress-tensor-ϵ-meson coupling in terms of $g_{A_1\epsilon\pi}$. With additional assumptions, a phenomenological result is obtained for the scale dimension of the pion field. Possible mechanisms are discussed which may give rise to large values of the rms radii of the form factors. As an example of additional phenomenological results obtainable from the scheme discussed here, a result is derived for the $fA_1\pi$ coupling. (auth)

53337 CONCERNING THE NATURE OF THE COSMOLOGICAL CONSTANT AND THE MECHANISM OF GRAVITATION OF VACUUM. **Gerdov, M. M.** **JETP Lett. (USSR) (Engl. Transl.); 13: No. 12, 498-500(20 Jun 1971).**

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 12, 704-6(20 Jun 1971).

Previous considerations are used to calculate the mass of the virtual particle responsible for the gravitation of the vacuum and the associated effect of expansion of the universe. The case is considered when the gravitational repulsion forces of the vacuum are equal to the gravitational attraction forces of the matter, corresponding to a red shift in the spectra of the quasars. It is found that the mass of the sought particle responsible for the gravitation of vacuum is $m \sim 1.6(10)^{-25}$ or $m \sim 170\ m_e$. That is, within the limits of the estimate the mass of the sought particle is of the order of the muon mass. (J.F.P.)

53338 PROBLEM OF EXPERIMENTAL CHECK OF GENERAL THEORY OF RELATIVITY. **Ryabushko, A. P.** **(Belorussian State Univ., Minsk).** **Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 6, 103-10(1970).** **(In Russian).**

A brief survey is given of the state of the problem of an experimental check of the general theory of relativity. Attention is given to certain new possibilities of an experimental check of this theory. It is shown that the real (physical) diameters of the orbits of Mercury, Venus, and the earth in the gravitational field of the sun are greater than their Newtonian values by approximately 16 to 19 km. It is ascertained also that the real lengths of the diameters of orbits in the field of a certain central body will be different in relation to the density of the substance in it. For greater density (and the same mass) the diameters are longer. The real radius of the Schwarzschild sphere was also found. In connection with the successes of radar astronomy the difference between the diameters of orbits according to Einstein and Newton for the theories of gravity can be found. It is noted that in experiments which were previously performed the delay of the echo-signal owing to the elongation of the trajectory was measured together with the delay expected because of the decrease of velocity of the radar beam near the sun. (tr-auth)

53339 BEARINGS OF GLOBAL HYPERBOLICITY ON EXISTENCE AND UNIQUENESS THEOREMS IN GENERAL RELATIVITY. **Choquet-Bruhat, Y.** **(Faculte des Sciences, Paris).** **Gen. Relativity Gravitation; 2: No. 1, 1-6(1970).**

A global, geometric, uniqueness theorem is developed for solutions of Einstein equations. This expresses for Einsteinian space-times a uniqueness analogous to that obtained for solutions of ordinary differential equations, that is, the existence of a unique maximal extension. The intrinsic Cauchy problem is stated, and proof is sketched of the semi-local, geometric, existence and uniqueness theorems of its solutions relative to Einstein equations using classical local theorems. The existence of a geometrically unique, maximal space-time solution of the problem is then shown, in the class of globally hyperbolic space-times. (UK)

53340 GENERAL RELATIVITY IN THE LARGE. **Gerock, R.** **(Syracuse Univ., N. Y.).** **Gen. Relativity Gravitation; 2: No. 1, 61-74(1971).**

A review is presented on the present status of global work in general relativity (as distinct from local considerations) under the headings: What is a reasonable space time; levels of structure; the physics of global structure; singularities; and stability. Some suggestions are also included on future work. (UK)

53341 HOMOGENEOUS RIEMANNIAN SPACES AND LIE ALGEBRAS OF KILLING FIELDS. **Schmidt, B. G.** **(Dept. of Applied Mathematics and Theoretical Physics, Cambridge, Eng.).** **Gen. Relativity Gravitation; 2: No. 2, 105-20(1971).**

The following new results are proved: Every Riemannian space admitting a multiply transitive Lie algebra of Killing fields is locally isometric to a homogeneous Riemannian space. For every closed connected subgroup H^0 of the invariance group of a nondegenerate quadratic form a homogeneous Riemannian space exists whose isotropy group contains H^0. Necessary and sufficient conditions are derived for a Lie algebra G to have a realization as multiply transitive Killing fields. These conditions are constructive in the sense that, for a given linear connected isotropy group, Lie algebras G can be calculated algebraically. It is shown how the Riemann tensor of a homogeneous space and its covariant derivatives can be expressed in terms of the metric at one point and the structure constants of the Lie algebra of Killing fields. (auth)

53342 NONCOVARIANT THEORY OF GRAVITATION. I. **rosen, Nathan** **(Israel Inst. of Tech., Haifa).** **Gen. Relativity Gravitation; 2: No. 2, 129-48(1971).**

Homogeneous isotropic models of the universe, based on the general theory of relativity, lead to the existence of a preferred frame of reference, which is similar to the absolute space of Newton, and a preferred time coordinate, which resembles the absolute time of Newton. These concepts seem to be in contradiction to the principle of covariance on which the general relativity theory is based. A theory of gravitation is therefore proposed which uses the world picture of general relativity but is not covariant. In the three crucial tests, the proposed theory gives the same results as the general relativity theory. However, in contrast to general relativity, the present theory predicts the emission of gravitational waves by spherically symmetric systems, and gravitational waves are found, in general, to have both transverse and longitudinal components. (auth)

53343 MULTIDIRECTIONAL, MULTIPOLARIZATION ANTENNAS FOR SCALAR AND TENSOR GRAVITATIONAL RADIATION. **Forward, Robert L. (Hughes Research Labs., Malibu, Calif.). Gen. Relativity Gravitation: 2: No. 2, 149-59(1971).**

Some gravitational radiation antenna designs are discussed which are capable of distinguishing between the spin-zero scalar radiation predicted by the Brans–Dicke theory of gravitation and the spin-two tensor radiation predicted by the Einstein theory of gravitation. The antennas will also give information concerning the direction to the source of radiation, and will measure the polarization of the tensor radiation. The designs consist of symmetric masses with appropriately spaced and oriented transducers. The transducers are combined to give orthogonal outputs. Linear combinations of these orthogonal outputs then are uniquely associated with the various possible combinations of radiation type, propagation direction and polarization orientation. (auth)

53344 SEARCH FOR GRAVITATIONAL WAVES. **Szalay, A. Sandor (Eoetvoes Lorand Univ., Hungary). Fiz. Szemle: 21: No. 5, 153-7(May 1971). (In Hungarian).**

There are very few experimental techniques suited to detect the effects of gravitational waves. Detection of gravitational waves is based on the measurement of stresses induced within bodies of slight changes in the gravitational field, i.e., of the space-time curvature. In case of periodic perturbations induced in an elastic body, excitation of normal modes may result in resonances if the frequency of the gravitational field coincides with that of the normal mode. The original experiments were carried out with a 1.5-ton aluminum cylinder, transducing the mechanical stresses into electrical voltage by means of piezoelectric crystals. To avoid local effects, two detectors were used in coincidence, at a distance of 1000 km from each other. The results indicated that the radiation sources are located among the about 10^{10} stars at the center of the galaxy. (TTT)

53345 PARTICLE PATHS OF GENERAL RELATIVITY AS GEODESICS OF AN AFFINE CONNECTION. **Burman, R. (Univ. of Western Australia, Nedlands). Bull. Aust. Math. Soc.; 3: No. 3, 325-35(1970).**

The motion of incoherent matter, and hence of test particles, in the presence of fields with an arbitrary energy-momentum tensor is considered. The equations of motion are obtained from Einstein's field equations and are written in the form of geodesic equations of an affine connection. The special cases of the electromagnetic field, the Proca field and a scalar field are discussed. (auth)

53346 GEOMETRIC INTERPRETATION OF CHRONOMETRIC INVARIANTS IN GENERAL THEORY OF RELATIVITY. **Novotny, J.; Horsky, J. (Faculty of Science, Brno). Czech. J. Phys.; 21: No. 7, 809-12(1971).**

The geometric interpretation of Zelmanov's chronometric invariants is given and their connection to observable quantities as well as the connection of Zelmanov's approach to the generally covariant Dehnen's method is found. (auth)

53347 ACTIVE GRAVITATIONAL MASS OF ELECTROMAGNETIC RADIATION. **Hegarty, J. C. (Boston Univ.). Nuovo Cim.; 5B: No. 1, 52-8(11 Sep 1971).**

The decay of a particle into two pulses of electromagnetic radiation is investigated to learn if the active gravitational mass of the radiation is twice that of the particle. The results show that, to first order in g_{ij}, the radiation tends to destroy the gravitational field; this is expressed mathematically by the equation $R_{ijkl} = 0$ for all space points lying inside the future light-cone whose apex is at the decay event. In addition the decay produces an impulse on a stationary particle which is perpendicular to the axis of propagation of the radiation and whose magnitude is inversely proportional to the normal distance between the particle and the axis of propagation. (auth)

53348 NONLINEAR SPINOR EQUATION AND ASYMMETRIC CONNECTION IN GENERAL RELATIVITY. **Hehl, F. W.; Datta, B. K. (Technische Univ., Clausthal-Zellerfeld, Ger.). J. Math. Phys. (N. Y.); 12: No. 7, 1334-9(Jul 1971).**

In order to take full account of spin in general relativity, it is necessary to consider space–time as a metric space with torsion, as was shown elsewhere. A Dirac particle in such a space is treated. The generalized Dirac equation turns out to be of a Heisenberg–Pauli type. The nonlinear terms induced by torsion express a universal spin–spin interaction of range zero. (auth)

53349 COVARIANCE, INVARIANCE, AND EQUIVALENCE: A VIEWPOINT. **Anderson, J. L. (Stevens Inst. of Tech., Hoboken, N. J.). Gen. Relativity Gravitation; 2: No. 2, 161-72 (1971).**

The underlying principles of general relativity, in view of its application to the phenomenon of gravitational collapse, are reexamined, precise statements of these principles given and their inter-relations discussed. According to Einstein's theory the gravitational field and the "geometry" of space–time are simultaneously characterized by a second rank symmetric tensor satisfying the Einstein equations. Einstein held that a principle of covariance and a principle of general covariance together with a Mach's Principle were the basis for general relativity and beyond this point very little agreement is found. Hence the formulations are given as a basis for further discussion. A brief review of a previous formulation (NSA 21: 18876) of the principle of general covariance is given and then related to the active and passive interpretations of co-ordinate transformations. The agreement with one statement of a principle of equivalence is then discussed. It is concluded that the Einstein group is the invariance group of all space–time systems. (UK)

53350 STATIC GRAVITATIONAL FIELD OF MULTIPOLES IN THE SECOND APPROXIMATION. **Pechlaner, E.; Das, A. (Simon Fraser Univ., Burnaby, Canada). J. Math. Phys. (N. Y.); 12: No. 7, 1066-8(Jul 1971).**

A method of obtaining the explicit form of the gravitational field of multipoles in the second approximation is furnished. The generalization of this method to any superposition of multipoles is straightforward. As an example, the second-order metric for the superposition of a monopole and a quadrupole is obtained. (auth)

53351 EQUAL-TIME COMMUTATION RELATIONS BETWEEN COMPONENTS OF A CURRENT AND THE ENERGY–MOMENTUM TENSOR. **Bergstroem, K.; Yngstroem, S. (Inst. of Theoretical Physics, Goteborg). J. Math. Phys. (N. Y.); 12: No. 7, 1083-7 (Jul 1971).**

An arbitrary physical system possessing a set of currents and an energy-momentum tensor is considered. Without the use of canonical commutation rules equal-time commutation relations between the components of the currents and the energy–momentum tensor are derived in a unified way. The currents and energy–momentum tensor are defined by the response of the physical system to the variations of external fields. The formalism of infinite-dimensional continuous transformation groups is utilized. (auth)

53352 INVARIANT APPROACH TO SPACE–TIME SYMMETRY. **Debney, George C. Jr. (Virginia Polytechnic Inst., Blacksburg. Virginia State Univ., Blacksburg). J. Math. Phys. (N. Y.); 12: No. 7, 1088-98(Jul 1971).**

A study is made of Killing vector fields in vacuum Einstein spaces with a restriction primarily to those fields whose associated bivector is nonnull. However, a well-known theorem of Robinson is modified slightly to show that if such a space admits a null bivector associated with a Killing vector, the space must be algebraically special. Consequently, all algebraically general spaces admit a nonnull Killing bivector (KBV) if they admit a symmetry at all. Furthermore, it is shown that if a vacuum Einstein space admits a spacelike or timelike Killing vector field whose associated KBV is nonnull, the Killing trajectories are not geodesics. Computation of invariants from the curvature tensor and the KBV allows an approach which gives a general classification to such spaces which admit at least one hypersurface orthogonal Killing vector field. A few geometrical properties involving the principal null directions of the KBV are also derived for the hypersurface orthogonal cases. In addition, a topological result follows immediately from the behavior of the invariant T. (auth)

53353 PARTICLES WITH SPIN IN A GRAVITATIONAL FIELD. **Mashhoon, Bahram (Princeton Univ., N. J.). J. Math. Phys. (N. Y.); 12: No. 7, 1075-7(Jul 1971).**

Papapetrou's covariant equations of motion for a spinning particle in a gravitational field are discussed. The equations of motion for the spin of a particle at rest outside a rotating mass are derived using the Kerr metric. It is shown that Schiff's formula for the mass–current effect follows from these equations in the lowest approximation. (auth)

53354 CLASSIFICATION OF THE HARRISON METRICS. **D'Inverno, R. A.; Russell-Clark, R. A. (Kings Coll., London). J. Math. Phys. (N. Y.); 12: No. 7, 1258-63(Jul 1971).**

Harrison's 40 space–time metrics were checked to see if they represent vacuum solutions. Four of them are found to be nonvacuum. The Petrov classification is found for all the metrics, and those of type D are placed in their (invariantly defined) Kinnersley classes. (auth)

53355 GRAVITATIONAL WAVES IN THE GENERAL THEORY OF RELATIVITY. III. ONE WAVE TYPE-III SOLUTIONS. **Dozmorov, I. M. (Moscow Higher Technical School). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 11, 121-5(1969). (In Russian).**

Methods and possibilities of the invariant theory of gravitational

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radiation (IVUZ, Fizika, No. 10, (1968)) are demonstrated, using as an example an accurate solution of Kaigorodov type III. Analysis of this solution permits the conclusion that it describes gravitational radiation with sources. (tr-auth)

53356 COMPLEX 2-FORM REPRESENTATION OF THE EINSTEIN EQUATIONS: THE PETROV TYPE III SOLUTIONS. Brans, Carl H. (Loyola Univ., New Orleans). J. Math. Phys. (N. Y.); 12: No. 8, 1616-19(Aug 1971)

The geometric structure equations of a manifold satisfying the vacuum Einstein equations are expressed in terms of a complexification of the space of 2-forms adapted to the Petrov classification. The Petrov type III problem is invariantly reduced to the solution of one partial differential equation. Examples of solutions containing one arbitrary function are given, corresponding to spaces with groups of motions of dimensions 0, 1, and 2. (auth)

Scattering Theory

Refer also to abstracts 53163, 53281, and 53844.

53357 (IAE-1970) SOLUTION OF THE INTEGRAL PEIERLS EQUATION. Sobolev, S. L.; Brudno, A. L.; Lavrova, M. S.; Mukhina, G. V.; Khodakov, V. A. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

One of the methods of solving the problem of the "black" cylinder located in a nonabsorbing medium is presented. The source of the particles is placed at infinity, and scattering is postulated as spherically symmetrical. The distribution of particle density is described by an integral equation (Peierl's equation). The method of solving such an equation is given. (tr-auth)

53358 PROPERTIES OF DUAL MULTILOOP AMPLITUDES. Alessandrini, V. (CERN, Geneva. Univ., Geneva); Amati, D. Nuovo Cim.; 4A: No. 4, 793-844(21 Aug 1971).

Previous results on the dual multiloop amplitude are extended by obtaining, from the unitarization procedure, the measure and domain of integration. The singularities of the amplitude, which arise from end points in the integration domain, are discussed by exploiting the simple geometrical interpretation of the theory. In particular, the singularities are investigated which give rise to divergences in planar diagrams as well as Pomeranchuk-like singularities in nonplanar ones. (auth)

53359 TWO- AND FOUR-PARTICLE CORRELATIONS IN THE MULTIPERIPHERAL MODEL. Ahmed, M. A. (Univ. of Khartoum, Sudan). Nuovo Cim.; 4A: No. 4, 932-56(21 Aug 1971).

A multiperipheral model that incorporates two- and four-particle correlations is studied. Integral equations for the forward absorptive two-particle scattering amplitude are derived, in the equal-mass case, both formally and explicitly. A Regge-pole model is then assumed for the absorptive part when only four-particle correlations are present and the shift in the intercept of the Regge trajectory due to the insertion of two-particle correlations is found. Numerical evaluations are also given. (auth)

53360 FIXED-ANGLE LIMITS OF MULTIPARTICLE AMPLITUDES. White, A. R. (Cambridge Univ., Eng.). Nuovo Cim.; 4A: No. 4, 957-82(21 Aug 1971).

Fixed-angle limits of multiparticle amplitudes are defined in terms of group variables. The behavior of invariant variables in these limits is calculated. It is shown that exponential decrease of multiparticle amplitudes in certain limits is desirable to avoid the generation of non-Regge multiangular-momentum singularities due to the presence of physical-region poles in multiparticle amplitudes. These limits are then shown to be precisely the fixed-angle limits. Possible generalizations to production amplitudes of the Orear and Krisch phenomenological fits to the fixed-angle behavior of the four-particle amplitude are also discussed. (auth)

53361 PARTIAL-WAVE PRODUCTION AMPLITUDES AND THE DIAGONALIZATION OF THE UNITARITY RELATIONS IN THE HELICITY FORMALISM. Wang, Kuo-hsiang (Pennsylvania State Univ., University Park). Phys. Rev., D; 4: No. 2, 489-516(15 Jul 1971).

A general study is made of the partial-wave amplitudes and their unitarity relations for the general N-body-to-N-body process in the helicity formalism. The partial-wave amplitude is so defined that it is a function of the subenergies that correspond to the noncoincident poles in a tree diagram. The partial-wave unitarity relations introduced here are diagonalized, and may supply the basis for introducing new models or improving others. The Wigner rotations and the crossing angles in the partial-wave expansion are explicitly given in terms of invariant variables. Some related topics such as the partial-wave recoupling condition, recoupling coefficients, etc., are discussed. The expressions obtained here can be applied to multiperipheral models and others. As a simple example, the contributions, elastic and inelastic, to the partial-wave amplitude via unitarity are obtained in a model of direct-channel scalar-meson dominance, with some approximations. (auth)

53362 PROJECTION OPERATOR IN THE DUAL-RESOANCE MODEL. Kikkawa, K. (City Coll., New York). Phys. Rev., D; 4: No. 2, 340-2(15 Jul 1971).

It is proved that the projection operator of the nonspurious states has a well-defined property in a certain space if and only if the Regge intercept is noninteger. A discussion is also given on the off-mass-shell extrapolation. (auth)

53363 ANALYTIC PROPERTIES OF THREE-PARTICLE AMPLITUDES IN THE SCATTERING-ANGLE VARIABLE. Avishai, Y. (Argonne National Lab., Ill.). Phys. Rev., D; 4: No. 2, 400-6(15 Jul 1971).

The elastic amplitude describing a scattering of a free particle on a two-particle bound state is here considered as a function of cos θ, where θ is the scattering angle. The two-body interactions were taken to be s-wave and separable. The results are: (1) The on-shell amplitude is analytic inside a Lehmann ellipse for all real energies, except for a finite interval on the negative E axis, and (2) for negative energy, the off-shell amplitude is analytic in the whole cos θ plane, apart from possible real left and right cuts, and in the Lehmann ellipse. Its asymptotic behavior in cos θ is determined by the leading Regge trajectory. (auth)

53364 T-MATRIX PERTURBATION THEORY FOR THE FADDEEV EQUATIONS. Becker, Stephen F.; Harrington, David R. (Rutgers—The State Univ., New Brunswick, N. J.). Phys. Rev., D; 4: No. 2, 411-15(15 Jul 1971).

A T-matrix perturbation theory for the Faddeev equations is developed in two different ways giving slightly differing results for the first-order correction to the ground-state energy of the three-body system, and both expressions differ from the result recently obtained by Fuda. The application of the theory to the system of three identical spinless particles is discussed. (auth)

53365 PROPERTIES OF SCATTERING AMPLITUDES AT HIGH ENERGY AND NONZERO MOMENTUM TRANSFER DEDUCED FROM SPECIFIED FORWARD BEHAVIOUR. Cornille, H.; Simao, F. R. A. (CEN de Saclay, Gif-sur-Yvette, France). Nuovo Cim.; 5A: 138-62(1 Sep 1971).

Assuming that the modulus of the forward symmetric and antisymmetric scattering amplitudes for large energy are of the type const $s(\log s)^{\beta\pm}$, $\gamma_0 = \sup(\beta^+, 2\beta^- - \beta^+)$ and γ ($\gamma_0 \leq \gamma \leq 2$) linked to the logarithmic part of the maximum number of contributing partial waves near the forward direction are so defined. For given γ_0 and γ, without further assumptions, rigorous results are deduced for the scattering amplitudes at nonzero momentum transfer t. Taking into account the assumption that the ratios of the physical scattering amplitudes to the forward ones are bounded for negative t by constants, improved results are obtained. The possibility is studied that as s approaches infinity the radios of the scattering amplitudes to the forward ones have the following property: at fixed tg(s), where g(s) is well defined, there exist nontrivial limits for these ratios. The properties of the absorptive parts of the scattering amplitudes in the complex t-plane, deduced from a specified forward behavior, are also studied. (auth)

53366 FACTORIZATION AND OPERATOR FORMALISM IN THE GENERALIZED VIRASORO MODEL. Del Giudice, E.; Di Vecchia, P. (Massachusetts Inst. of Tech., Cambridge). Nuovo Cim.; 5A: No. 1, 90-102(1 Sep 1971).

The properties of duality and factorization of the generalization to N-particle scattering—recently given by Shapiro for $\alpha(0) = 2$—of the Virasoro model are studied. In particular this fully symmetric model (FSM) is written using the usual operator formalism with the addition of another infinite set of harmonic oscillators b_n. The residue of each pole is shown to factorize in a finite number of terms independently of the number of external particles. The spectrum increases exponentially with the energy by a factor $\sqrt{2}$ more than in the generalized Veneziano model (GVM). Two infinite sets of Ward operators are shown to be present and the physical states on mass shell are defined as in the GVM. (auth)

53367 HIGH-ENERGY SCATTERING ON A SMOOTH POTENTIAL. Mestvirishvili, M. A.; Rcheulishvili, G. L. (Inst. of High-Energy Physics, Serpukhov, USSR). Teor. Mat. Fiz.; 8: No. 2, 206-14(Aug 1971). (In Russian).

The high-energy behavior of the scattering amplitude is studied for the smooth quasipotential $V(r) = V_0(k)\ [\exp(-\alpha\sqrt{r^2 + \alpha^2})/\sqrt{r^2 + \alpha^2}]$. (auth)

53368 LAGRANGIAN AND SCATTERING MATRIX. Medvedev, B. V.: Pavlov, V. P.; Sukhanov, A. D. (Mathematics Inst., Moscow. Moscow Mining Inst.). Teor. Mat. Fiz.; 8: No. 2, 153-60(Aug 1971). (In Russian).

It is demonstrated by a number of concrete examples that in realistic field theories there is no direct correlation between the property of the Lagrangian to be Hermitian (resp., local) and the unitarity (resp., causality) of the scattering matrix. (auth)

53369 QUASICLASSICAL APPROXIMATION IN THE INVERSE SCATTERING PROBLEM. Khudyakov, S. V. Zh. Eksp. Teor. Fiz.; 60: No. 6, 2040-4(Jun 1971). (In Russian).

An approximate solution of the inverse scattering problem for a central field with a fixed energy is derived for the case of strongly oscillating cross sections. The imaginary part of the potential is determined in the quasiclassical approximation on the basis of the real part of the potential of the optical model and the differential cross section. (auth)

53370 COORDINATE ASYMPTOTICS OF THE THREE-PARTICLE WAVE FUNCTION. Merkur'ev, S. P. (Leningrad State Univ.). Teor. Mat. Fiz.; 8: No. 2, 235-50(Aug 1971). (In Russian).

Coordinate asymptotics of the wave function is studied for the nonrelativistic three-particle system, taking into account the processes (3 → 3). The main attention is paid to the double scattering effects. It is shown that in the coordinate space regions where the formally constructed scattering amplitude tends to infinity the asymptotics of the wave function of (3 → 3) process is described by means of the Frenel integrals. (auth)

53371 AMPLITUDE FOR EXCITED NONSPURIOUS PARTICLES IN DUAL-RESONANCE MODELS WITH ARBITRARY INTERCEPT. Napolitano, E.; Sciuto, S. (Univ., Turin). Lett. Nuovo Cim.; 1: No. 26, 1095-8(26 Jun 1971).

The generalization of the amplitude for N nonspurious excited particles is discussed in the case of an arbitrary value of the intercept a, releasing the on-mass-shell condition for the external states. (L.B.S.)

53372 SCATTERING AMPLITUDES FOR PHYSICAL STATES IN DUAL-RESONANCE MODELS. Friedman, K. A.; Rosenzweig, C.; Sukhatme, U. P. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Lett. Nuovo Cim.; 1: No. 26, 1109-13 (26 Jun 1971).

Operators that have the property of generating only physical states in the Virasoro case (a = 1) were recently found by Di Vecchia and Fubini (Lett. Nuovo Cimento, 1: 823(1971). The operators are used to compute scattering amplitudes for excited particles, in particular, for physical states coupled to two scalars. (L.B.S.)

53373 QUASI-TWO PARTICLE EQUATIONS FOR THE SCATTERING OF TWO BOUND STATES (AND OTHER FOUR-PARTICLE PROBLEMS). Riordan, F. (Univ. of Birmingham, Eng.). Lett. Nuovo Cim.; 2: No. 7, 359-62(14 Aug 1971).

The Faddeev method for solving the four-particle equation by expressing the four-particle transition operator T(z) in terms of transition operators for the subproblems is considered. An operator function of complex subenergies with the same matrix elements as T(z) on the energy-subenergy shell is defined by an equation whose kernel has no continuous spectrum and involves no convolutions of T(z). The quasi-particle method is used to reduce the equation to a coupled set of two-particle equations. (L.B.S.)

53374 NONRELATIVISTIC S-MATRIX THEORY EQUATIONS. Grashin, A. F. (Moscow Regional Teacher's Inst.). Teor. Mat. Fiz.; 8: No. 1, 73-84(Jul 1971). (In Russian).

The complete set of equations of nonrelativistic S-matrix theory is proposed. The set includes the Ekstein equations as well as new additional equations eliminating the ambiguity in the solutions of the previously known bilinear equations. General relations between various amplitudes are found with the aid of obtained equations. The two-particle case with separable interaction is discussed as a concrete example. (auth)

53375 INVARIANCE GROUPS OF THE PHASE SPACE AND RELATIVISTIC THREE-PARTICLE STATES. Bogoslovskii, G. Yu. (Moscow State Univ.). Teor. Mat. Fiz.; 8: No. 1, 85-96 (Jul 1971). (In Russian).

A new approach to the classification of states of the three relativistic particles is proposed. The basic idea of the method consists in the existence of a finite group H of transformations leaving invariant the energetic surface equation as well as the relativistic three-particle phase-volume. The equations determining a one-parameter subgroup of H are found and the group itself is found in the case of the three identical particles. The specific feature of this group is that the particle exchange is the element of it. The complete set of commuting Hermitian operators, including the exchange operator, is constructed on the basis of the Lie algebra of generators of H. The complete orthonormal system of states is obtained which possesses necessary symmetry properties with respect to the exchange. Kinematical variables used in the problem map the physical region on the Dalitz plot on a ring. (auth)

53376 STURM–LIOUVILLE FUNCTIONS APPLIED TO SOLVING THE SCHROEDINGER EQUATION IN ANISOTROPIC SAXON–WOODS POTENTIAL. Gareev, F. A.; Ivanova, S. P.; Shirikova, N. Yu. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 8: No. 1, 97-108(Jul 1971). (In Russian).

A method of solving the Schrödinger equation in an anisotropic potential with finite depth for bound states E < 0 is proposed. The one-particle wave function is represented as a superposition of the eigen-functions of the Sturm–Liouville problem. The problem of taking into account the influence of the continuous spectra on the bound states is automatically solved. (auth)

53377 GENERALIZED VIRASORO MODELS. Brower, R. C.; Goddard, P. (CERN, Geneva). Lett. Nuovo Cim.; 1: No. 26, 1075-81(26 Jun 1971).

An N-point generalization of the Virasoro amplitude for any positive integer trajectory intercept is presented. The operator formalism, factorization, and the spectrum are discussed. (L.B.S.)

53378 REGGEON AMPLITUDE AND DUALITY SUM RULE. Jen, Chian-li; Kang, Kyungsik; Shen, Pu; Tan, Chung-I (Brown Univ., Providence). Phys. Rev. Lett.; 27: No. 11, 754-7(13 Sep 1971).

Based on the dual amplitude analysis of the "ditriple" Regge limits in inclusive hadronic reactions, the general properties of the Reggeon–Reggeon amplitude are conjectured and a duality sum rule is suggested. From this sum rule, predictions are made on the two-Reggeon-particle and triple-Reggeon couplings for diffraction dissociations. (auth)

53379 DUALITY AND THE POMERANCHUK TRAJECTORY. Potupa, A. S. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 1, 100-5(1971). (In Russian).

The hypothesis of the existence of the W-trajectory with its very broad resonances is considered, and its duality with the Pomeranchuk trajectory. The connection between W-resonances with SU_3 classification and fireballs is further examined. (tr-auth)

53380 AZIMUTHAL TWO-PARTICLE CORRELATIONS FROM M = 0 LORENTZ POLES. Bassetto, A.; Toller, M. (CERN, Geneva). Lett. Nuovo Cim.; 2: No. 8, 409-12(21 Aug 1971).

Previous studies of azimuthal two-particle correlations from M = 0 Lorentz poles are extended, releasing the condition that the observed particles are in the pionization region. The investigation is based on the assumption that the pomeron is essentially a Lorentz pole with factorized residues. An expression is obtained for the two-particle inclusive distribution. (L.B.S.)

53381 CROSSED CHANNEL EXCHANGE AND REGGE ASYMPTOTIC BEHAVIOUR OF SCATTERING AMPLITUDES. Kawasaki, Mamoru; Kobayashi, Masanori (Hiroshima Univ. Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1879-88(Jun 1971).

From the viewpoint that Regge behavior is due to crossed channel exchanges, the infinite one-particle-exchange (IOPE) approach, especially a model which generates cuts in the direct channel variable s, is discussed. At the present stage this model shows Regge behavior locally in the small negative momentum transfer t region. (auth)

53382 DUAL RESONANCE AMPLITUDE CORRESPONDING TO GLOBULAR FEYNMAN DIAGRAMS. Muta, Taizo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1935-8(Jun 1971).

Following the conjecture on the correspondence between the dual resonance amplitude and the very high order Feynman diagram, the dual resonance amplitude corresponding to the globular Feynman diagram is calculated. It is found that it develops essential singularities in the Lorentz-invariant variables. (auth)

53383 SELF-REPRODUCING POMERON AND DIFFRACTION SCATTERING. Fujisaki, Haruo (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1939-43(Jun 1971).

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By the use of the self-reproducing Pomeron, asymptotic behavior of diffraction scattering is investigated, on the assumption of a general form of the discontinuity across the Pomeranchuk branch cut. (auth)

53384 SPLIT-WIDTH DUAL MODEL. Shafee, S.; Shaffe, A. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett.; 36B: No. 4, 347-9(20 Sep 1971).

A crossing-symmetric amplitude with asymptotic Regge behavior and second-sheet resonances with different widths for parents and each daughter is proposed. With a suitable choice of a function, ghosts and tachyons can be eliminated. (auth)

53385 PLANAR VS. LOCAL DUALITY. Roy, D. P. (Rutherford High Energy Lab., Chilton, Eng.). Lett. Nuovo Cim.; 2: No. 11, 545-8(11 Sep 1971).

An attempt is made to clarify the distinction between planar and local duality in regard to the underlying assumptions. A number of predictions of local duality which are not shared by the planar version are listed. The implication of the two versions of duality to the perturbative approach to the t-channel Regge cuts is noted. (L.B.S.)

53386 USE OF THE FINITE BORN SERIES IN POTENTIAL SCATTERING. Singh, S. R. (Queen's Univ., Kingston, Ont.). Nuovo Cim.; 5B: No. 1, 1-10(11 Sep 1971).

An analysis of the Born series in potential scattering is presented. Wellner's formula for improving the convergence of a perturbation series is rederived and compared with some similar formulations. Convergence of the original perturbation expansion of the phase shift and its more convergent form obtained from the iterative scheme are studied. The numerical studies are made for S-wave scattering from an exponential potential. It is found that the first two terms of the Born series for the phase shift approximate the exact values quite closely over a fairly wide range of potential strength, except near threshold, where a further application of the iterative method improves the results significantly. (auth)

53387 LEAST-SQUARES TECHNIQUE FOR SCATTERING. Ladanyi, K. (Max-Planck-Institut fuer Physik und Astrophysik, Munich); Szondy, T. Nuovo Cim.; 5B: No. 1, 70-8(11 Sep 1971).

A modified least-squares method is introduced with intent to explore effective numerical techniques for many-body scattering calculations. The least-squares method is illustrated by applications to the nonrelativistic potential scattering. Numerical calculations are carried out for an attractive exponential potential. (auth)

53388 CONTRIBUTIONS OF IRREDUCIBLE FEYNMAN DIAGRAMS TO ENERGY DEPENDENCE OF QUASI-PARTICLE SCATTERING AMPLITUDE. Goeritz, G.-H.; Zint, P.-G. (Justus Liebig-Univ., Giessen, Ger.). Z. Phys.; 246: No. 2, 183-8(1971). (In German).

The evaluation of the Feynman diagrams contributing to the quasi-particle scattering amplitude Γ^{ω} exhibits for special momenta the impossibility of expanding this function into a power series in terms of ω at $\omega = 0$ because of the existence of a branch cut in the complex energy plane. The value of the discontinuity across the cut is proportional to $|\omega|$. (auth)

53389 CONSTRUCTION OF RELATIVISITIC POTENTIALS WHEN THE ENERGY IS FIXED. Coudray, Christiane (Institut de Physique Nucleaire, Orsay, France); Coz, Marcel. J. Math. Phys. (N. Y.); 12: No. 7, 1166-78(Jul 1971).

Generalized translation operators are used for solving the relativistic inverse problem at fixed energy and study the extension of Newton's method. Both the Klein–Gordon equation and the Dirac equation are considered. The determination of the so-called coefficients of interpolation remains a crucial point of the solution. In the case of the Klein–Gordon equation, these coefficients are obtained by the same system of equations as the system obtained for nonrelativistic spinless particles. Therefore, the same singular problem is encountered whether the spinless particles are relativistic or not. In the case of the Dirac equation, the problem with two potentials differs from the problem where only one potential is present. When there are two potentials, a generalized translation operator exists, and the inverse problem can be solved by inverting a singular matrix equation for the coefficients of interpolation. When only one potential is present, the solution of the inverse problem is restricted by a compatibility requirement. (auth)

53390 T MATIX FOR THE EXPONENTIAL POTENTIAL. Fuda, Michael G. (State Univ. of New York, Buffalo). J. Math. Phys. (N. Y.); 12: No. 7, 1163-6(Jul 1971).

An analytic expression for the s-wave part of the exponential potential T matrix is obtained. The separability of the residue of the T matrix at bound or virtual-state poles is demonstrated explicitly. (auth)

53391 ANALYTIC CONTINUATION OF THE REGULAR SOLUTION OF THE SCHROEDINGER EQUATION IN THE COMPLEX ANGULAR MOMENTUM PLANE. Kelemen, P. J. (Indiana Univ., Bloomington). J. Math. Phys. (N. Y.); 12: No. 7, 1142-55(Jul 1971).

A method of performing the analytic continuation of functions that are Stieltjes or Laplace transforms is developed. The method is applied to find the regular solution and its asymptotic behavior in the left half-plane. The irregular solution and the S matrix are briefly discussed. (auth)

53392 NEW TOOL FOR SCATTERING STUDIES. Sabatier, Pierre C. (Indiana Univ., Bloomington). J. Math. Phys. (N. Y.); 12: No. 7, 1303-26(Jul 1971).

In potential scattering, from the transformation kernel, a function $K(\rho)$ is constructed whose Bessel transforms are the Jost functions. $K(\rho)$ contains the whole information on the potential $V(\rho)$. There is a one-to-one correspondence between the two functions, and they are related, in both senses of this correspondence, through integral equations. Since the relation between $K(\rho)$ and the phase shift is very direct, it is a useful tool for all analyses of the relations between the information contained in the dynamics of the problem (viz., the potential) and the measurable information (viz., the phase shifts). Besides, the derivation of $K(\rho)$ makes clear that a similar study can be done in all cases to which the Gel'fand–Levitan scheme applies and therefore in most scattering problems in physics. (auth)

53393 DISPERSION RELATIONS, FROISSART–GRIBOV TRANSFORMS, AND DISTRIBUTIONS. Auberson, G.; Mahoux, G. (CEN de Saclay, Gif-sur-Yvette, France). J. Math. Phys. (N. Y.); 12: No. 7, 1242-57(Jul 1971).

A family of distribution spaces K'_λ is constructed. Each K'_λ completely characterizes the (tempered) distributions which are the discontinuity of functions holomorphic in a cut plane with given boundedness properties and the Froissart–Gribov transforms of which are holomorphic in a half-plane with given asymp totic behavior. The main results are stated in two reciprocal theorems. Such a reciprocity shows the adequacy of the spaces K'_λ. Some mathematical properties of these ones are given after introducing the proper test function spaces K_λ. In particular, a representation theorem for the distributions in K'_λ is proven. (auth)

53394 SOME PROPERTIES OF A DUAL MULTILOOP PLANAR OPERATOR FREE OF SPURIOUS STATES. Cremmer, E. (CERN, Geneva). Nucl. Phys.; B31: No. 2, 477-511 (1971).

Some properties of a dual multiloop planar operator free of spurious states are studied. For this aim, it is constructed by a simple iterative method in a form which allows direct proof of some duality properties, such as the possibility of a tree to go around one tadpole, or in the two-loop case the transformation of one tadpole into a nonplanar self-energy. The relation between some invariance properties of the integration measure and the integration domain is discussed. (auth)

53395 STATIONARY-STATE SCATTERING THEORY. Amrein, W. O.; Georgescu, V.; Jauch, J. M. (Univ., Geneva). Helv. Phys. Acta; 44: No. 3, 407-34(15 May 1971).

A rigorous mathematical derivation of the stationary state scattering theory from the time-dependent theory is given. The basic tool used is the spectral integral for operator-valued functions with an operator-valued measure. The chief result is the correct interpretation and validation of the formal expressions often used in stationary-state scattering theory. (auth)

53396 REMARKS ON THE EXISTENCE OF SOLUTIONS OF THE TWO-PARTICLE LIPPMANN–SCHWINGER EQUATION. Rajagopal, A. K.; Shastry, C. S. (Louisiana State Univ., Baton Rouge). J. Math. Phys. (N. Y.); 12: No. 8, 1515-20(Aug 1971).

The following is proven: The kernel K_l of the partial wave Lippmann–Schwinger equation for the lth partial wave with complex energy having positive- or negative-definite imaginary part belongs to the Hilbert–Schmidt (L^2) class if the potential V is spherically symmetric and such that $\lim r^{\delta}V(r) = 0$, $-\infty < \delta < 3/2$, $V(r)_{r\to\infty} = O(r^{-\eta})$, $\eta > 1/2$, for $V(r) = g/r^{\alpha}$, $1 < \alpha < 3/2$, the kernel K of the full Lippmann–Schwinger equation satisfies $\mathrm{Tr}\,\{(K^{\dagger})^m K^m\} < \infty$, if $\alpha > (2m + 1)/2m$, $m = 2, 3, \ldots$. For $1/2 < \alpha \leq 1$, $\mathrm{Tr}\,\{(K^{\dagger})^m K^m\}$ is not absolutely convergent for any finite m, even though, for each partial wave, K_l belongs to L^2 class. Obtaining expressions for the T matrix in terms of eigensolutions of the mth iterated kernel when it belongs to L^2 class is also considered. (auth)

53397 S MATRIX AND LOW ENERGY THEOREM IN THE THEORY OF CORRELATION FUNCTIONS. Dashen, Roger; Ma, Shang-keng (Inst. for Advanced Study, Princeton, N. J.). J. Math. Phys. (N. Y.); 12: No. 8, 1449-71(Aug 1971).

The current correlation functions in statistical mechanics were examined from a scattering theory viewpoint. In the light of low energy theorems, the connection between the long wavelength, low-frequency correlation functions of conserved currents and the on-shell scattering matrix elements are studied which describe the collision processes taking place in the thermodynamical system of interest. Explicit general formulas are derived for the leading correction terms to the ideal gas correlation functions. These correction terms include the effect of two-body scatterings and double scatterings in three-body events. They are expressed in terms of two-body cross section, time delay, and the quantum analog of the distance of closest approach. Their connection to the second virial coefficient is established through sum rules. The relation between the results and the Boltzmann equation is discussed. (auth)

53398 FREDHOLM METHODS IN THE THREE-BODY PROBLEM. I. Newton, Roger G. (Indiana Univ., Bloomington). J. Math. Phys. (N. Y.); 12: No. 8, 1552-67(Aug 1971).

It is shown that, for three particles interacting via potentials that are bounded and decrease at least as fast as $r^{-7/2}$, the Green's function of the Schroedinger equation at physical energies can be calculated by the classical Fredholm methods for $\mathfrak{L}^2$ kernels. (auth)

53399 REGGE TRAJECTORIES AT HIGH ENERGIES FOR A CLASS OF ANALYTIC POTENTIALS. Johnson, Porter W. (Illinois Inst. of Tech., Chicago). J. Math. Phys. (N. Y.); 12: No. 8, 1610-16(Aug 1971).

Scattering by nonsingular, energy-independent, central potentials $V(r)$ which are analytic in r in a sector of half-angle θ about the real positive axis is considered. Simple considerations show that at high energies all Regge trajectories leave the sector of the angular momentum plane given by $|\arg l| \leq \theta$. One finds in general, however, that Regge trajectories remain in the right half l plane at sufficiently high energies for potentials of the above type. The Wood–Saxon potential is analyzed numerically. It is found that Regge trajectories which represent bound states remain in the right half l plane at high energies. (auth)

Particle Accelerators

Refer also to abstracts 52926, 52988, 53038, 53085, 53743, and 53788.

53400 (70-CNA-625) TRIUMF STATUS REPORT. Stonehill, B. C. (Dilworth, Secord, Meagher and Associates Ltd., Toronto (Ontario)); Burgerjon, J. J. (TRI-Univ. Meson Facility, Vancouver (British Columbia)). May 1970. 10p. (CONF-700564-20). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

Topics include buildings and site, center region model, research and development, and machine components. (W.H.K.)

53401 (A/CONF.49/P-1) VALUE OF A LOW-ENERGY ACCELERATOR IN ADVANCING NUCLEAR TECHNOLOGY IN DEVELOPING COUNTRIES. McCallum, G. J. (Institute of Nuclear Sciences, Lower Hutt (New Zealand)). May 1971. 18p. (CONF-710901-365). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The use of a 3-MeV Van de Graaff accelerator in the nuclear research program in New Zealand is described. The research program is outlined and specific research including isotope production and charged particle activation analysis and related techniques are discussed. (W.H.K.)

53402 (A/CONF.49/P-442) ACCELERATORS IN MEDICINE, INDUSTRY, AND AGRICULTURE. Komar, E. G. (State Atomic Energy Committee, USSR). Jun 1971. 17p. (CONF-710901-384). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Characteristics of various betatrons, electrostatic accelerators, and linear accelerators in the USSR for use in medicine, defectoscopy, activation analysis, development of new technological processes, increasing the productivity of agriculture, and other practical purposes are described. (W.H.K.)

53403 (A/CONF.49/P-449) SERPUKHOV PROTON ACCELERATOR AND PHYSICAL INVESTIGATIONS USING PARTICLE BEAMS WITH ENERGY UP TO 70 GeV. Logunov, A. A. (Institute for High Energy Physics, Serpukhov (USSR)). Jun 1971. 13p. (CONF-710901-385). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The operating parameters and capabilities of the Serpukhov Synchrotron are described, and the high-energy research program is outlined. (W.H.K.)

53404 (A/CONF.49/P-695) NEW TOOL IN PHYSICS OF ELEMENTARY PARTICLES. Sarantsev, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). Apr 1971. 13p. (In Russian). (CONF-710901-497). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The report discusses a modern status of works on the collective ion acceleration and perspectives of their development in near future. On the basis of experiments set up in various institutes in the USSR, forecasts are given of the development of the methods using electron rings, the plasma method and the high current electron beam method. (auth)

53405 (AD-714141) NRL VAN DE GRAAFF OPERATION, JANUARY 1–JUNE 30, 1970. Dunning, K. L. (Naval Research Lab., Washington, D. C.). Aug 1970. 33p. (NRL-MR-2173). NTIS.

The report is the fifth of a series of semiannual summaries on the use of the 5-MV Van de Graaff accelerator and associated instruments. The period 1 January 1970 to 30 June 1970 is covered. A brief statistical summary is presented, a few important developments concerning the maintenance and improvement of apparatus are discussed, and brief accounts of on-going and recently completed research projects are given. (auth) (USGRDR)

53406 (AD-722472) OPERATION OF THE ACCELERATOR STORAGE RING TO PROVIDE ULTRAVIOLET RADIATION. Interim Report, December 1, 1969–November 30, 1970. Rowe, Ednor M. (Wisconsin Univ., Stoughton. Physical Sciences Lab.). 30 Nov 1970. Contract F44620-70-C-0029. 76p. (AFOSR-TR-71-794). NTIS.

It was proposed to operate the electron storage ring as the source of ultraviolet radiation for the performance of experiments in solid state, atomic, and surface physics. In addition to operating the storage ring as a source of ultraviolet radiation for physical and chemical experimentation, it was proposed to set up a permanent experimental station at the north port of the storage ring. This was to be accomplished through the acquisition of a normal incidence monochromator, experimental chamber and a focusing system. The installation of a parallel beam line at the west port was planned as a means for accommodating more experiments at the ring. A study of the wave shifter was to be undertaken in order to determine the feasibility of enriching the synchrotron radiation spectrum in the shorter wavelength range through the use of orbit perturbing magnets. In addition, several improvements in the storage ring and the injector synchrotron were planned. These included the completion of a high power RF supply, and the replacement of several trimmer coil power supplies on the injector synchrotron and beam transport line. The progress made on these projects is detailed. (auth) (USGRDR)

53407 (CEA-CONF-1766) CONTAMINATION OCCURRING WITH A LINEAR ACCELERATOR AS A RESULT OF THE FAILURE OF THE NATURAL URANIUM TARGET SHEATH. MEASUREMENTS MADE AND EQUIPMENT TO ENSURE ENVIRONMENTAL PROTECTION. Vialettes, H. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971. 17p. (In French). (CONF-710423-3). Dep. NTIS (U. S. Sales Only).

From International congress on protection against accelerator and space radiation; Geneva, Switzerland (26 Apr 1971).

Activity measurements were effected at Saclay using the 60-MeV linear accelerator in order to estimate the hazards presented by contamination due to the release of fission products. About twenty radioelements with half-lives lying between 30 min and 30 years were detected. Discharge into the atmosphere of ^{138}Cs, ^{139}Ba, and ^{91}Sr–^{91}Y was observed. Sampling performed in the target room indicated the presence of the following fission products: ^{133}I, ^{122}Sb, ^{132}Te, ^{141}Ce, ^{124}Sb, and ^{131}I. ^{135}I, ^{133}I, ^{99}Mo, ^{131}I, and ^{135}Xe were discharged into the water circuits. In order to estimate the hazard presented by an incident with similar target, the mass activity of the fission products with average or long half-lives found in the target was determined. The equipment ensuring the radiation protection of the installation and environment is described: control of air contamination in the target room, discharge of the contaminated air, and cooling of the target are considered. (France)

53408 (CONF-701002–, pp 377-84) HIGH-ACCURACY TOTAL-CROSS-SECTION MEASUREMENTS WITH THE NBS LINAC. Schwartz, R. B.; Heaton II, H. T.; Schrack, R. A. (National Bureau of Standards, Washington, D. C.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

A high-accuracy fast-neutron time-of-flight spectrometer used for neutron energies between 0.5 and 20 MeV is described. The neutrons are produced by a 2-nsec-wide electron-beam pulse from the National Bureau of Standards Linac. The resolution, with a 40-m flight path, is approximately 0.1 nsec/m, and the accuracy of the measurements is estimated to be 1%. (auth)

53409 (DESY-R-1-70/5) INVESTIGATIONS ON DISTURBANCES IN THE STORAGE RING CAUSED BY THE DETECTOR FIELD AND THEIR CORRECTIONS. Ripken, Gerhard ([Deutsches Elektronen-Synchrotron, Hamburg (West Germany)]). Jun 1970. 44p. (In German). Dep. NTIS (U. S. Sales Only).

The solenoid acting as particle detector distorts the electron–positron beams in the storage ring. It is shown that the distortions can be corrected through homogenous magnetic fields that are arranged perpendicular to the beam. Especially beam-bump-fields at the two crossing points and solenoid fields that are counterdirected to the detector field eliminate closed-orbit-shift at the crossing points as well as the coupling of betatron oscillations. These corrections also eliminate torsion of the beam around its axis and distortions of dispersion. (H.B.G.)

53410 (IFVE-SKU-70-51) PHYSICAL SUBSTANTIATION ON THE PROTON SLOW EJECTION SYSTEM AT IHEP 70 GeV ACCELERATOR. Myznikov, K. P.; Tatarenko, V. M.; Fedotov, Yu. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 44p. (In Russian). Dep. NTIS (U. S. Sales Only).

The results of detailed investigation of particle movement at slow ejection are presented. The physical substantiation for the choice of the main elements of the system that will allow proton beam extraction at the IHEP accelerator to be performed with 90% efficiency during 1 sec in the energy range from 20 up to 70 GeV is discussed. The correction mode of the accelerator magnetic field at slow extraction is proposed. The conditions of the extracted beam focusing and a system that allows the extracted beam to be focused into a spot with 2 mm diameter and angular divergence ±3 mrad is considered. The main requirement and tolerances on the ejection and focusing system are formulated. (auth)

53411 (JINR-P-13-5803) NANOSECOND LIFETIME MEASUREMENTS OF EXCITED NUCLEAR STATES OF THE HEAVY ION CYCLOTRON U-300. PART II. BEAM HANDLING. Hagemann, U.; Neubert, W.; Stary, F.; Schulze, W. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

The beam lay-out at the heavy ion cyclotron U-300 for performing in-beam measurements of prompt and delayed gamma spectra is described. (auth)

53412 (JINR-P9-5873) MEASUREMENT OF THE ACCELERATED BEAM PHASE IN THE ELECTRON MODEL OF THE RING CYCLOTRON. Anosov, V. N.; Kochkin, V. A.; Novikov, D. L.; Onishchenko, L. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Jul 1971. 21p. (In Russian). Dep. NTIS (U. S. Sales Only).

The apparatus is described for measurement of the beam phase with respect to the accelerating device. The method of the absolute binding of the beam phase is described, and the experimental data on the phase behavior depending on the accelerator parameters are given. The accuracy of the absolute beam phase measurement obtained in the experiments is not worse than ±5°. The devices for the beam phase measurement were designed in the Laboratory of Nuclear Problems of the Joint Institute for Nuclear Research. (auth)

53413 (LA-4586) LAMPF USERS HANDBOOK (PRELIMINARY VERSION). Agnew, Lewis E. Jr. (Los Alamos Scientific Lab., N. Mex.). Jan 1971. Contract W-7405-eng-36. 55p. Dep. NTIS.

Descriptions of the LAMPF accelerator; experimental facilities and beams; and experimental equipment, accessories, and services are presented to provide the experimenter with the basic information to make a realistic research proposal at LAMPF. (auth)

53414 (LA-DC-12942) GADGETS DEMONSTRATING PRINCIPLES INVOLVED IN POLARIZED ION SOURCES. McKibben, J. L. (Los Alamos Scientific Lab., N. Mex.). [1971]. 7p. (CONF-711012-4). Dep. NTIS.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

A pair of spheres 15 cm in diameter and simulating a polarized particle in the restricted sense that they have angular momentum and magnetic dipole moment have been fabricated. Each is supported on an air bearing and when placed close to each other interact. An external magnetic field has also been made so that aspects of the Breit-Rabi diagram can be visualized. A single sphere placed in the field can be shown to follow the field if it is rotated slowly with respect to the precessional frequency. Another device is a triple pendulum and is used to dramatize the nature of the 3 level quantum mechanical interaction involved in the nuclear spin filter. (auth)

53415 (LA-DC-12943) BENEFICIAL EFFECT OF AN AIR LEAK INTO THE DUOPLASMATRON OF THE LASL POLARIZED SOURCE. McKibben, J. L. (Los Alamos Scientific Lab., N. Mex.). [1971]. 4p. (CONF-711012-5). Dep. NTIS.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

The output beam from a Lamb-shift type of polarized ion source has been approximately doubled by a small leak of various types of gases strange to the normal output. A description of the positive ion source, accel-decel system, magnetic lens, and cesium cell is given. Test results suggest that the space charge is more completely neutralized if ions having distinctly different velocities are present simultaneously in the beam. (auth)

53416 (LA-DC-12995) LAMPF (LOS ALAMOS MESON PHYSICS FACILITY) AS A NEUTRON SOURCE FOR RADIATION DAMAGE EXPERIMENTS. Green, W. V.; Dudziak, D.; Zukas, E. (Los Alamos Scientific Lab., N. Mex.). [nd]. 2p. (CONF-710624-1). Dep. NTIS.

From International working session on fusion reactor technology conference; Oak Ridge, Tenn. (28 Jun 1971).

An experimental facility at LAMPF for high temperature radiation damage experiments for fusion reactor development is proposed. (W.H.K.)

53417 (LA-DC-13014) LAMPF H^- ION SOURCE DEVELOPMENT. Allison, Paul W.; Emigh, C. Robert (Los Alamos Scientific Lab., N. Mex.). [1971]. 3p. (CONF-711012-1). Dep. NTIS.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

The design, operation, and performance of the H^- ion source are discussed. The proton source and charge exchange canal with a spherical Pierce geometry are described. (W.H.K.)

53418 (LA-DC-13015) LASL EXPERIENCE WITH A DUOPLASMATRON FEEDING A 750-kV EXACT PIERCE COLUMN. Emigh, C. Robert; Meyer, Earl A.; Mueller, Donald W.; Stevens, Ralph R. Jr. (Los Alamos Scientific Lab., N. Mex.). [1971]. 7p. (CONF-711012-2). Dep. NTIS.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

The LAMPF H^+ ion source and 750-kV Pierce accelerating column are designed on the basis of a plane parallel beam of protons 1.4 cm in diameter. Performance meets theoretical expectations within a few percent when account is taken of the extra space charge loading by slower moving molecular ions which make up one-fourth of the beam current. Fast-rising, fast-falling, flat-topped pulses of 500 μsec duration and 50 mA beam current are obtained at 120 Hz. The beam has reasonably uniform density, low aberration, and an emittance area under 2π mrad cm. Experiences with plasma apertures are described. X-ray radiation in the 30 to 50 mA beam current range is very low and is correlated with zero beam current to the Pierce electrodes. Radiation increases sharply outside this design range as expected. (auth)

53419 (LA-DC-13016) CURRENT STATUS OF POLARIZED ION SOURCES. McKibben, J. L. (Los Alamos Scientific Lab., N. Mex.). [1971]. 24p. (CONF-710815-1). Dep. NTIS.

From second international conference on polarized targets; Berkeley, Calif. (30 Aug 1971).

The characteristics of the conventional type of polarized ion source and of the Lamb-shift type of source are compared as a source of positive ions for a cyclotron or terminal of a Van de Graaff. The characteristics of the same sources adapted to deliver negative ions for a tandem Van de Graaff are also compared. Specific examples are chosen to illustrate the comparison. A brief discussion of the potentiality of the Kaminsky concept (whereby deuterons channeled through a monocrystalline Ni foil have been found to be polarized) is made. Finally, the use of the polarized source to produce polarized neutrons is discussed briefly. (auth)

53420 (LA-DC-13017) LAMB-SHIFT POLARIZED ION SOURCE FOR THE LOS ALAMOS MESON PHYSICS FACILITY. Lawrence, G. P. (Los Alamos Scientific Lab., N. Mex.). [1971]. 4p. (CONF-711012-3). Dep. NTIS.

From Symposium on ion sources and formation of ion beams; Upton, N. Y. (19 Oct 1971).

Design objectives and considerations for the Los Alamos Meson Physics Facility polarized proton source are presented. A source of the Lamb-shift type is planned, which in addition to its attractive beam intensity, polarization, and emittance characteristics, possesses other capabilities which considerably increase the potential usefulness of the device. (auth)

53421 (LA-DC-13019) STATUS OF LOS ALAMOS MESON PHYSICS FACILITY. Rosen, Louis (Los Alamos Scientific Lab., N. Mex.). [1971]. 26p. (CONF-710911-8). Dep. NTIS.

From fourth international conference on high energy physics and nuclear structure; Dubna, USSR (7 Sep 1971).

Design parameters of the LAMPE are given; experimental facilities are described; and proposals for various experiments are listed. (W.H.K.)

53422 (NP-18906) ANNUAL REPORT, 1970. (European Organization for Nuclear Research, Geneva (Switzerland)). 1971. 179p.

CERN SYNCHROTRON—development of, 1970
HIGH-ENERGY PHYSICS—research at CERN, 1970
NUCLEAR PHYSICS—research at CERN, 1970
RADIATION DETECTORS, BUBBLE CHAMBER—development at CERN, 1970
STORAGE RINGS—development and testing of ISR, 1970 (R.W.R.)

53423 (RHEL/R-214) INFORMATION ON THE NIMROD EXPERIMENTAL PROGRAMME. Salter, D. C. (comp.) (Rutherford High Energy Lab., Chilton (England)). Apr 1971. 35p. Dep. NTIS (U. S. Sales Only). UK 40p.

A list of experiments completed, in progress, or accepted for running at Nimrod is presented. The details given include a very brief description of the aims of the experiment, the group concerned, the relevant beam line and, where appropriate, the publications resulting from the experiment. A list of experiments carried out at C.E.R.N. (Geneva) by Nimrod Groups is also included. (auth)

53424 (RHEL/R-219) NIMROD OPERATION AND DEVELOPMENT QUARTERLY REPORT, JANUARY 1-MARCH 31, 1971. Gray, D. E. (ed.) (Rutherford High Energy Lab., Chilton (England)). May 1971. 24p. Dep. NTIS (U. S. Sales Only). UK 27p.

The Nimrod beam was on for High Energy Physics Research for 66.9% of HEP scheduled operating time. Four experiments continued through and two commenced in this quarter. Some notes on personal dosimetry are given. The computer control system, associated with Nimrod's third extracted proton beam, X3, is reviewed. (auth)

53425 (RHEL/R-221) USE OF INTERPRETIVE SOFTWARE IN HIGH ENERGY PHYSICS EXPERIMENTS. Hyman, J. T. (Rutherford High Energy Lab., Chilton (England)). Jun 1971. 8p. Dep. NTIS (U. S. Sales Only). UK 13p.

Some new ideas for the use of small computers in HEP experiments are put forward. The use of interpretive software is proposed as the means of realizing the potential of computers at all stages of an experiment up to the final analysis. The possibility of long-distance remote control of experiments is noted. (UK)

53426 (SLAC-Trans-133) NONLINEAR COLLIDING-BEAM EFFECT. Jejcic, A.; Le Duff, J. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Translated by R. Williams for Stanford Linear Accelerator Center, Calif., from report LAL-RT-10-71. 47p. Dep. NTIS.

An analytical approach to nonlinear space charge effects in electron-positron colliding beam rings is presented. In particular, the distribution function of the betatron frequencies is computed for some special cases of interest, such as head-on collisions, incomplete compensation with four beams, and crossing at an angle. Moreover a qualitative study of the amplitude evolution is made, taking into account the dispersion which can bring some particles into dangerous nonlinear resonances and which might lead to beam enlargement and losses. (auth)

53427 (TRI-71-2) REVMOC: A MONTE CARLO PROGRAM FOR CALCULATING CHARGED PARTICLE TRANSMISSION THROUGH SPECTROMETERS AND BEAM LINES. Kitching, P. (TRI-Univ. Meson Facility, Vancouver (British Columbia)). Apr 1971. 75p. Dep. NTIS (U. S. Sales Only).

REVMOC is a Monte Carlo computer program, written in FORTRAN IV, for the design and analysis of magnetic spectrometers and beam transport systems. In tracing charged particles through a system of magnets, first order theory is used by the program, that is, in a Taylor's series expansion about the principal trajectory, second and higher order terms are neglected. The program attempts to simulate the physical processes, such as decay, multiple scattering, nuclear scattering absorption, and calculates corrections for any loss or gain of particles from these causes. The program will also give distributions of particles accepted by the system as a function of a variety of variables, if this is desired. (auth)

53428 (UCRL-20655, pp 2-37) NIMROD EXPERIMENTAL PROGRAMME. Manning, G. (Rutherford High Energy Lab., Chilton (England)). Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

A summary is given of the current experimental program and the experiments planned in the immediate future for the Nimrod accelerator. A brief description is also given of the available beams. The proposed improvements in Nimrod and its facilities are discussed. (L.B.S.)

53429 (UCRL-20655, pp 38a-58) ZGS PROGRAM. Jovanovic, Drasko; Cork, Bruce (Argonne National Lab., Ill.). Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

The brief description of the ZGS program is given in two parts: a discussion of the experimental beam configuration; and a list of experiments that either were completed in the last year or are presently set up in the experimental area. (L.B.S.)

53430 (UCRL-20655, pp 59-71) BEVATRON PROGRAM. Lofgren, Edward J.; Holley, William R.; Sah, Richard C. (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

The operating capabilities of the Bevatron, the planned improvement program, and the experimental program are described. (L.B.S.)

53431 (UCRL-20655, pp 72a-90) INTERMEDIATE ENERGY PROGRAM AT THE AGS (LESS THAN 8 GeV). Berley, David (Brookhaven National Lab., Upton, N. Y.). Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

Summaries are given of the experimental facilities available for counter spark chamber experiments, the particles available to bubble chambers, and the experimental program in the intermediate energy region. (L.B.S.)

53432 (UCRL-20655, pp 91-116) CERN PROGRAMME. Muller, F. ([California Univ., Berkeley. Lawrence Radiation Lab.] European Organization for Nuclear Research, Geneva (Switzerland)). Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

A general description is given of the experimental facilities and of the evolution of the CERN physics program. (L.B.S.)

53433 (UCRL-20655, pp 117-28) POLARIZED TARGET TECHNIQUES. Shapiro, Gilbert (California Univ., Berkeley). Jun 1971.

From Workshop on particle physics at intermediate energies; Pasadena, Calif. (29 Mar 1971).

A review is given of experiments that have been performed using polarized targets according to three categories: measurement of the normal polarization parameter in elastic scattering; tests of discrete symmetries and measurement of intrinsic parity in hadron interactions; and analyses of the polarization of the recoil particle after elastic scattering in a plane containing the target polarization vector—the so-called R and A measurements. (L.B.S.)

53434 (UCRL-Trans-1451) COUPLING RESONANCES OF THE TRANSVERSE OSCILLATIONS OF TWO CIRCULAR BEAMS. Zenkevich, P. R.; Koshkarev, D. G. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translated by F. D. Jones for Univ. of California, Lawrence Radiation Lab., Berkeley, Calif., from report ITEF-841. 33p. Dep. NTIS.

It is shown that a system of two circular beams will exhibit coupling resonances analogous to the well known resonances which occur under the influence of external perturbations in circular beams of singly-charged particles. The general resonance condition is of the form $nq_1 + mQ_2 = k$, where Q_1 and Q_2 are the

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natural oscillation frequencies of particles in the first and second beams respectively and m, n, and k are integers. Formulae are obtained for the widths of the resonance bands from a resonance of arbitrary order, and passage through resonances is investigated. Analysis of these results shows that two-beam interactions provide a stringent restriction on the upper frequency limit of self-stabilized Bennett–Budker beams. (auth)

53435 (UCRL-Trans-1453) NUMERICAL ANALYSIS OF THE NONLINEAR STAGE OF DEVELOPMENT OF THE RADIATIVE INSTABILITY OF RELATIVISTIC ELECTRON RINGS. **Bonch-Osmolovskii, A. G.; Makhan'kov, V. G.; Tsytovich, V. N.; Shchinov, B. G.** (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by B. Thayne for Univ. of California, Lawrence Radiation Lab., Berkeley, from report JINR-P9-5622. 26p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 28110. (auth)

53436 MONTE CARLO TECHNIQUES IN EVALUATION OF HIGH-INTENSITY MAGNET FLUXES AND FIELDS. **Shepherd, Marian Margaret.** Saskatoon,; Univ. of Saskatchewan (1971). 111p. University Microfilms Order No. 71-20,633.
Thesis.

The design of the pole pieces required by the Intense Neutron Generator (ING) led to the described investigations of numerical methods for magnetic field calculations. Ways of improving the rate of convergence are explored for the relaxation method. A consideration of the Monte Carlo method of random walks leads to a new method of carrying out walks in a region. Also, the introduction of an accelerating factor, analogous to the overrelaxation factor, gives "oversweeping"; which is substantially faster than sweeping. It is found that the region being swept can be divided into sub-regions which can be treated separately. If the sub-regions are rectangular, the boundary distributions can be found analytically with a great saving in time. The method combines the solution from the sub-regions whether these solutions are found by sweeping or by the analytic expressions. A new Mixed Analytic-Numeric method is investigated. (TSS) (Diss. Abstr. Int., B)

53437 REPORT ON THE ENGINEERING OF BUILDINGS FOR ELECTRON LINAC OF TOHOKU UNIVERSITY. **Okajima, Nobuo; Yamamoto, Moriyuki; Mizushina, Tomoyuki; Maeda, Hidenori; Kitamura, Takeshi** (Taisei Construction Co. Ltd., Tokyo). Taisei Kensetsu Gijutsu Kenkyusho-Ho; No. 3, 93-127(Oct 1970). (In Japanese).

The main assembly of accelerator and beam transport systems is located 6 m under the ground and extends 71 m. One of the beam transport systems is perpendicular to the direction of the accelerator, branching 11m. The accelerator room is 57 m in length and 3 m in width with 2.3 m width side space for the piping system. The load distribution is unbalanced due to irregular configuration of the layout together with massive and heavy shieldings. Shielding design problems are discussed. (TSS) (Japan)

53438 RADIATION AREA SAFETY INTERLOCK SYSTEM FOR A 3-MeV ACCELERATOR. **Hummer, Goerge J.** (Brookhaven National Lab., Upton, N. Y.). Health Phys.; 21: No. 3, 453-6(Sep 1971).

Multiple target-room facilities now in use at numerous research centers are potential health hazards. A fail-safe interlock system servicing four independent target areas and a particle-accelerator complex now in use at Brookhaven National Laboratory are described. (auth)

53439 STUDY OF THE FIELD OF AN ELECTROMAGNET USED AS A MAGNETIC PRISM. **Ringhiopol, I.** (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 3, 349-59(1971). (In French).

An analytical and experimental study of the plane parallel field produced by an electromagnet is presented. The results are used in solving the motion of charged particles in an iron gap. (auth)

53440 PRECISE CENTER-SETTLING DEVICE FOR QUADRUPOLE MAGNETS. **Kobayashi, Masaaki** (Tokyo Univ.); **Tanaka, Jiro; Baba, Hitoshi; Yamashita, Sukeaki.** Jap. J. Appl. Phys.; 10: No. 9, 1195-1202(Sep 1971).

An apparatus for centering drift tube quadrupole magnets and measuring their harmonic field contents is described together with the search coil and its calibration method. Sensitivity within 0.5 μm and reproducibility within ±2 μm can be obtained for the magnetic center location. Harmonic field components in four types of model magnets are measured for different pole shapes. (auth)

53441 LIFE-TIME OF TRITIUM TARGETS AND RELEASE OF TRITIUM FROM D–T NEUTRON GENERATORS. **Broerse, J. J.; Engels, A. C.; Groen, J. S.** (Radiobiological Inst. TNO, Rijswijk, Netherlands). Int. J. Appl. Radiat. Isotop.; 22: No. 8, 486-9(Aug 1971).

Health physics problems result from tritium releases from targets of D–T neutron generators. Neutron yield from the target is found to depend on the length of bombardment and the energy of the bombarding deuterons. The mechanism of target deterioration, especially in relation to the tritium which might be lost by the target, was investigated by measuring the tritium content of the oil of the accelerator vacuum pumps. Tritium activity in released gas in the accelerator room is found always to be $<10^{-4}$ μCu/ml. Data produced are compared with those of previous experimenters and possible types of filters for the forepump exhaust are noted. (UK)

53442 PRODUCTION OF ^{15}O USING A RELATIVELY LOW ENERGY PARTICLE ACCELERATOR WITH A VACUUM GRADIENT SYSTEM AS A WINDOW. **Mantel, J.; Damico, C. J.; Kurtzman, R. S.** (Wayne State Univ., Detroit). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 707-14(Aug 1971).

A vacuum gradient system has been developed which can replace the conventional window of a particle accelerator, allowing the use of relatively low energy deuterons to bombard gaseous targets. This system consists of 4 communicating chambers which can be evacuated to produce a high vacuum at the accelerator end with a poor vacuum at the level of the gaseous target. Using this device with a 400 keV Van de Graaff generator and a nitrogen target, a significant quantity of oxygen 15 was produced. With relatively minor modifications to the system, clinically useful quantities of the isotope can be obtained. (auth)

53443 NANOSECOND PULSED ELECTRON ACCELERATOR. **Yamamoto, Takayoshi; Ohkuma, Juzo; Kawanishi, Masaharu** (Osaka Univ.). Rev. Sci. Instrum.; 42: No. 9, 1366-7(Sep 1971).

A mercury switch pulse generator for nanosecond pulsing of a high-current electron accelerator is described. (W.H.K.)

53444 NOTE ON THE DESIGN AND CONSTRUCTION OF A SCATTERING CHAMBER. **Hussain, M.** (Univ. of Dacca, Pakistan); **Rahman, F.; Sabir, A.** Nucl. Sci. Appl., Ser. B; 5: 45-6 (Oct 1969).

The 11 × 5 inch scattering chamber for studying charged particle reactions at the Dacca Van de Graaf accelerator is described. (W.H.K.)

53445 AUTOMATIC LIQUID AIR REPLENISHER. **Hussain, Emdad; Alam, Nurul** (Atomic Energy Centre, Dacca, Pakistan). Nucl. Sci. Appl., Ser. B; 5: 31-2(Oct 1969).

An automatic liquid air filler involving no moving parts as made and being used in topping cold traps of Van de Graaff accelerator is reported. It is simple, cheap and easy to operate. (auth)

53446 NONLINEAR WAVES IN UNCOMPENSATED ELECTRON BEAMS. **Fainberg, Ya. B.; Shapiro, V. D.; Shevchenko, V. I.** (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 61: No. 1, 198-207(Jul 1971). (In Russian).

Nonlinear stationary waves propagating along the axis of a ring electron beam similar to the E layer of a self-stabilized electron beam are investigated. Dispersion relations for nonlinear periodic waves are obtained and the maximal electric field amplitudes in them are determined. Conditions of existence of solitary waves are considered. (auth)

53447 γ RAY ANALYSIS ON RADIOACTIVE AEROSOL AND DUST IN THE MACHINE HALL OF A CYCLOTRON. **Katao, K.; Ohata, T.** (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys.; 21: No. 3, 475-9(Sep 1971).

The radionuclides in the working environment of the machine hall of the IPCR 160 cm variable energy cyclotron were studied with a high resolution Ge(Li) γ-ray spectrometer. The sampling procedure is explained and the spectrometer described. Measurements were delayed until 20 days after sampling so that short lived isotopes had decayed and longer lived radionuclides were evident. Airborne nuclides found were ^{54}Mn, ^{56,57,58,60}Co, ^{65}Zn, ^{182}Ta, ^{183,184}Re, and ^{185}Os. ^{7}Be and ^{22}Na were found by the smear method. Using a NaI(Tl) crystal counting equipment, the deposition of ^{65}Zn in various positions around the cyclotron was measured. The γ spectra for various regions in the cyclotron were compared and their characteristics tabulated. In the air, a noticeable amount of radionuclides, produced by bombardment of tungsten-made parts, were found. Their activities depended on the operating conditions and schedule of the cyclotron. The significance of these to the internal exposure of personnel is not well known. (UK)

53448 CALCULATIONS ON BUNCHING OF AN ION BEAM WITH A MULTIPLE-APERTURE KLYSTRON SYSTEM. **Seeliger,**

D.; Seidel, K.; Weder, W. (Technische Hochschule, Dresden). Exp. Tech. Phys.; 18: No. 4-5, 287-99(1970). (In German).

By means of sine wave voltages, exact phase relationships are calculated for the bunching of a stationary ion beam in a multiple aperture klystron system for a Van de Graaff accelerator. Of special practical significance are the cases of both synchronous and asynchronous bunching on double and triple aperture systems which are computed and compared to single aperture bunching. Results show that through a triple aperture system, with appropriate position and strength of the modulation planes, more than 40% of the stationary ion current can be compressed to ion impulses of 2 nsec duration and 20 nsec pulse intervals. Changes of ion energy are examined with respect to effects on bunching properties. (tr-auth)

53449 STUDY OF THE OSCILLATING ELECTRON SOURCES DISCHARGE AND ION BEAM. Marghitu, Silvia (Institutul de Fizica Atomica, Bucharest). Stud. Cercet. Fiz.; 23: No. 2, 145-59(1971). (In Rumanian).

Penning ion sources are frequently employed in accelerators. It is difficult to establish a mathematical model of the discharge, since there is a great number of geometrical and physical parameters acting on the discharge and ion beam current values. Experimental studies on a Penning ion source which permit changing the cathodes to modify the discharge geometry and to vary the functional parameters are described. Some conclusions about suitable design and the functional regime for sources used in neutron generators are pointed out. (auth)

53450 INDUCTION LINEAR ACCELERATOR. Bosamykin, V. S.; Gerasimov, A. I.; Pavlovskii, A. I. Russian Patent 242,287. 17 Mar 1970. Filed 15 May 1967. (In Russian).

An induction linear accelerator in the form of a group of iron-free transformers is described. One end of the primary is open and provided with a magnetic screen, in order to simplify construction of the accelerator. (R.W.R.)

53451 ION LINEAR ACCELERATOR. Vladimirskii, V. V.; Kapchinskii, I. M.; Teplyakov, V. A. Russian Patent 265,312. 9 Mar 1970. Filed 25 Oct 1968. (In Russian).

An ion linear accelerator with a quadrupole acceleration and focusing system is described. This system consists of four conductors, running along the accelerating cavity every 90°. The conductors are shaped such that their distances from the axis of the accelerator varies: when one pair is at its minimum distance, the opposite pair is at its maximum distance. This quadrupole design helps eliminate unwanted low-energy ions from the source. (R.W.R.)

53452 EXPERIENCES DURING THE EARLY RUNNING-IN PHASE OF THE ISR. Johnsen, Kjell (CERN, Geneva). J. Inst. Nucl. Eng.; 12: No. 4, 101-5(Jul-Aug 1971).

The CERN Intersection Storage Rings (ISR) produced the first proton collisions at 15 GeV on January 27, 1971. These tests and other earlier ones with beam in only one ring are described. Further data and observations during the continuing running-in period are included. (auth) (UK)

53453 ENERGY RECOVERY IN AN ELECTRON BEAM. Arenshtam, A. I.; Meshkov, I. N.; Ponomarenko, V. G.; (and others) (Inst. of Nuclear Physics, Novosibirsk, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 252-3(Aug 1971).
Translated from Zh. Tekh. Fiz.; 41: No. 2, 336-8(Feb 1971).

A device is described in which the particle energy is recorded in an electron beam ($U = 100$ kV, $I = 1$ A). Using electrostatic and magnetic shields in the collector, it is possible to achieve $\Delta I/I \gtrsim 10^{-3}$, $\Delta U/U \lesssim 1.3 \cdot 10^{-2}$ (ΔI is the current loss, and ΔU is the recovery potential), which is appreciably better than results published in the literature. An original method is described for measuring the transverse components of electron velocity in the beam; the method is based on pulsed beam deflection. (auth)

53454 NEXT GENERATION OF HIGH ENERGY PHYSICS. Cole, Francis T. (National Accelerator Lab., Batavia, Ill.). New Sci. Sci. J.; 51: No. 767, 508-10(2 Sep 1971).

The world's largest particle accelerator, a 500 GeV separated function synchrotron, will soon start operations at Illinois. The design of the facility and associated laboratories is outlined. It is stated that 150 requests for experimental facilities have been received and of these 30 to 40 proposals have been accepted and preparatory work is under way. Examples of these experiments are given including: observation of neutrino reactions, searches for quarks and magnetic monopoles proton–proton scattering, and scattering of muons by protons. (UK)

53455 HIGH-INTENSITY SOURCE OF He^- IONS. D'yachkov, B. A.; Zinenko, V. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 305-6(Aug 1971).
Translated from Zh. Tekh. Fiz.; 41: No. 2, 404-6(Feb 1971).

The choice of material for a charge-exchange target in a high-intensity source of negative helium ions is discussed. Study of the transformation $He^+ \rightarrow He^-$ shows that a charge-exchange target of sodium vapor is to be preferred. At the optimum energy of 12 keV the maximum yield in sodium vapor is 1.7 ± 0.1%. (auth)

53456 PHASE-ENERGY CHARACTERISTICS OF AN ACCELERATOR BUNCHER. Ostrovskii, E. K.; Zykov, A. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 260-2(Aug 1971).
Translated from Zh. Tekh. Fiz.; 41: No. 2, 347-9(Feb 1971).

A method is proposed for measuring the energy dependence of bunches used in linear electron accelerators. Monoenergetic bunches with small phase spread are used as probes. (auth)

53457 DEPENDENCE OF BEAM INTENSITY ON CHARGE DISTRIBUTION IN A BUNCH. Khlestkov, Yu. A.; Tereshkin, Yu. M. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 2, 254-9(Aug 1971).
Translated from Zh. Tekh. Fiz.; 41: No. 2, 339-46(Feb 1971).

The maximum beam intensity in linear and cyclic proton accelerators as a function of charge distribution in the bunches, assuming incomplete shielding of the beam by the walls, is studied. The calculated value of the maximum intensity depends significantly on the distribution. Consideration of wall effects leads to an increase in maximum intensity. With a distribution decreasing sharply toward the edge of the bunch, the beam is essentially completely shielded. (auth)

53458 TARGET HANDLING SYSTEM FOR THE 200-GeV PROTON ACCELERATOR. Grimson, J. H.; Lindberg, J. F.; Maschke, A. W.; Simanton, J. R.; Simon, J. P. (National Accelerator Lab., Batavia, Ill.). pp 135-42 of Proceedings of the 18th Conference on Remote Systems Technology, Washington, D. C., November 1970. /Farmakes, Ruth (ed.). Hinsdale, Ill.; American Nuclear Society, Inc. (1970).
From eighteenth conference on remote systems technology; Washington, D. C. (Nov 1970). See CONF-701132.

Proton beam-line equipment and shielding in the 200-GeV accelerator external target areas will become radioactive. A shielded target laboratory equipped with a remote handling system will service these target areas. Radioactive equipment will be brought to the laboratory on transporters, resembling train-cars, for service. In this way, targets and associated equipment can be remotely maintained or modified without extensive accelerator downtime. (auth)

53459 LAMB-SHIFT SOURCES. Donnally, Bailey L. (Lake Forest Coll., Ill.). pp 295-316 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).
From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

The design and operation of Lamb-shift polarized ion sources are described. The production of H(2S) states, polarization schemes, selective ionization, and the performance of Lamb-shift sources are discussed. (46 references) (W.H.K.)

53460 POLARIZED SOLID TARGETS. Jeffries, C. D. (Univ. of California, Berkeley). pp 351-72 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).
From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

Three methods for dynamic polarization of solid targets are discussed including microwave dynamic polarization, optical pumping in solids, and spin refrigerators. Also, a brief discussion of recent advances in thermal equilibrium methods is presented. (72 references) (W.H.K.)

53461 SOURCE OF POLARIZED PROTONS AND DEUTERONS FOR THE TERMINAL OF A PRESSURIZED 6-MV VAN DE GRAAFF ACCELERATOR. Paetz gen. Schieck, H.; Busch, C. E.; Keane, J. A.; Donoghue, T. R. (Ohio State Univ., Columbus). pp 810-12 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).
From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53462 UNIVERSITY OF MINNESOTA POLARIZED NEGATIVE ION SOURCE. Poppe, C. H.; Shkolnik, V.; Watson, D. L. (Univ. of Minnesota, Minneapolis). pp 813-14 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53463 RECENT PERFORMANCE OF THE GRENOBLE POLARIZED SOURCE. Belmont, J. L.; Bagieu, G.; Ripouteau, F.; (and others) (Institut des Sciences Nucleaires, Grenoble, France). pp 815-16 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53464 AUSTRALIAN NATIONAL UNIVERSITY ATOMIC BEAM POLARIZED NEGATIVE ION SOURCE. Glavish, H. F. (Univ. of Auckland, N. Z.); MacKinnon, B. A.; Walker, I. J.; Whineray, S.; Titterton, E. W. pp 817-18 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53465 SOURCE OF POLARIZED NEGATIVE HYDROGEN IONS FOR THE ETH TANDEM ACCELERATOR. Grueebler, W.; Koenig, V.; Schmelzbach, P. A. (Eidgenoessische Technische Hochschule, Zurich). pp 819-20 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53466 SOURCE OF POLARIZED LITHIUM IONS. Ebinghaus, H. (Univ., Hamburg). pp 821-2 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53467 KARLSRUHE POLARIZED ION SOURCE. Brueckmann, H. (Kernforschungszentrum, Karlsruhe, Ger. Univ., Karlsruhe, Ger.). pp 823-7 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53468 PERFORMANCE OF THE LASL POLARIZED SOURCE. McKibben, J. L.; Lawrence, G. P.; Ohlsen, G. G. (Los Alamos Scientific Lab., N. Mex.). pp 828-31 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53469 UNIVERSITY OF WASHINGTON LAMB-SHIFT POLARIZED ION SOURCES. Preikschat, E.; Michel, G.; Roth, G. W.; Cramer, J. G. Jr.; Weitkamp, W. G. (Univ. of Washington, Seattle). pp 832-4 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53470 LAMB-SHIFT POLARIZED ION SOURCES FOR TANDEM ACCELERATORS AT WISCONSIN AND TRIANGLE UNIVERSTIES NUCLEAR LABORATORY. Clegg, T. B. (Univ. of North Carolina, Chapel Hill. Triangle Universities Nuclear Lab., Durham, N. C.); Bissinger, G. A.; Haeberli, W.; Quin, P. A. pp 835-6 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53471 LAMB-SHIFT POLARIZED ION SOURCE. Sanada, J. (Tokyo Univ. of Education); Mikumo, T.; Kobayashi, S.; (and others). pp 837-8 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53472 ENERGY DEPENDENCE OF CHARGE EXCHANGE REACTIONS APPLIED SUCCESSFULLY TO LAMB-SHIFT-TYPE ION SOURCES. Bechtold, V.; Brueckmann, H.; Finken, D.; (and others) (Kernforschungszentrum, Karlsruhe, Ger. Univ., Karlsruhe, Ger.). pp 839-41 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53473 ABSOLUTE BEAM POLARIZATION DETERMINATION FOR THE LASL LAMB-SHIFT SOURCE BY THE QUENCH RATIO METHOD. Ohlsen, G. G.; Lawrence, G. P.; Keaton, P. W. Jr.; McKibben, J. L.; Armstrong, D. D. (Los Alamos Scientific Lab., N. Mex.). pp 842-5 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53474 PROPOSAL FOR A LAMB-SHIFT POLARIMETER. Brolley, J. E.; Lawrence, G. P.; Ohlsen, G. G. (Los Alamos Scientific Lab., N. Mex.). pp 846-8 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53475 FIGURES OF MERIT FOR POLARIZED DEUTERON BEAMS. Keaton, P. W. Jr.; Ohlsen, G. G. (Los Alamos Scientific Lab., N. Mex.). pp 852-4 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53476 TRANSFER MATRIX METHOD FOR CALCULATING SPIN ABERRATIONS IN THE TRANSPORT OF POLARIZED BEAMS. Stevens, R. R. Jr.; Ohlsen, G. G. (Los Alamos Scientific Lab., N. Mex.). pp 858-60 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53477 CHARACTERISTICS OF AlK AND Al(NH$_4$) ALUM AS NEW MATERIALS FOR POLARIZED PROTON TARGETS. Bendt, P. J. (Los Alamos Scientific Lab., N. Mex.). pp 885-6 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53478 PROPOSED ULTRA-LOW TEMPERATURE POLARIZED TARGET FOR USE WITH SINGLE-BURST NEUTRON SOURCES. Lemley, J. R.; Keyworth, G. A. (Los Alamos Scientific Lab., N. Mex.). pp 887-9 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53479 PROPOSED 0.4 K POLARIZED PROTON TARGET CRYOSTAT FOR LAMPF. Edeskuty, F. J.; Hwang, C. F.; Williamson, K. D. Jr. (Los Alamos Scientific Lab., N. Mex.). pp 890-2 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53480 FROZEN POLARIZED TARGET. Nicholas, D. J.; Read, S. F. J.; Russell, F. M.; Williams, W. G. (Rutherford High Energy Lab., Chilton, Eng.). pp 893-5 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53481 NEW TECHNIQUE FOR j-VALUE DETERMINATIONS WITH A DYNAMICALLY POLARIZED PROTON TARGET AND BACKSCATTERED NEUTRONS. Dabbs, J. W. T.; Walker, W. W.; Dress, W. B.; Miller, P. D. (Oak Ridge National Lab., Tenn.). pp 896-8 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53482 EXPERIMENT TO COMPRESS POLARIZED ^{3}He GAS. Timsit, R. S.; Daniels, J. M.; Dennig, E. I.; (and others) (Univ. of Toronto). pp 903-5 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53483 DETERMINATION OF THE POLARIZATION OF A POLARIZED ^{3}He GAS TARGET BY THE PULSED NMR TECHNIQUE. Klinger, W.; Hauer, N. (Univ., Erlangen, Ger.). pp 906-8 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53484 INFLUENCE OF THE ABSORPTION OF THE PUMPING LIGHT ON THE DEGREE OF POLARIZATION OF AN OPTICALLY PUMPED He TARGET. Brueckmann, H.; Lueck, W.; Schmidt, F. K. (Kernforschungszentrum, Karlsruhe, Ger. Univ., Karlsruhe, Ger.). pp 909-10 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

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PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 52158, 52164, 52166, 52167, 53441, 53843, 54256, and 54267–54270.

53485 (CONF-701002) NEUTRON STANDARDS AND FLUX NORMALIZATION. Proceedings of a Symposium held at Argonne National Laboratory, Argonne, Illinois, October 21–23, 1970. (Argonne National Lab., Ill.). Aug 1971. 525p. Dep. NTIS.

Separate abstracts were prepared for 40 of the 43 papers presented. The three remaining papers were previously included in NSA. For abstracts of these three papers see CONF-701002-1, CONF-701002-2, and CONF-701002-3 in a cumulative report number index. (W.H.K.)

For abstracts of individual papers see: 51850–51853, 51879, 51880, 52303, 53223, 53408, 53486–53489, 53510–53414, 53591–53603, 53731–53738, and 54256.

53486 (CONF-701002–, pp 362-76) FILTERED-BEAM TECHNIQUES. Simpson, O. D.; Smith, J. R.; Rogers, J. W. (Idaho Nuclear Corp., Idaho Falls).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

High-intensity of 2-, 24.5-, and 144-keV neutrons have been produced with filtered-beam techniques. The beams of neutrons are produced by placing thick filters of scandium, iron, and silicon into beam holes of the Materials Testing Reactor. Development work has consisted in determining optimum lengths, finding techniques to deal with backgrounds, and making some pilot total neutron-cross-section measurements. The filtered beams constitute a distinctive set of neutron sources and should assist greatly in the understanding of neutron cross sections in the important thousand-electron-volt energy region. (auth)

53487 (CONF-701002–, pp 410-14) SOME VIEWPOINTS ON CROSS-SECTION STANDARDS AND RELATED PROBLEMS FOR FAST-NEUTRON ELASTIC- AND INELASTIC-SCATTERING MEASUREMENTS. Holmqvist, B. (Aktiebolaget Atomenergi, Studsvik (Sweden)).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

Problems connected with accurate measurements of fast-neutron elastic- and inelastic-scattering cross sections include a need for standard cross sections. In this paper the interest is concentrated on cross-section standards that can be used in the 100-keV energy range. But, in addition, problems concerning the million-electron-volt energy range are briefly discussed. Usually elastic and inelastic cross-section experiments are performed relative to the n-p and C(n,n) cross sections. However, the large recoil effect of the (n,p) reaction makes carbon a better standard below a neutron energy of about 1.5 MeV. Some comments are also made about the general properties of organic scintillation detectors and lithium glass scintillation detectors used for measurements of fast-neutron fluxes. (auth)

53488 (CONF-701002–, pp 417-36) FISSION-NEUTRON SPECTRA: MACROSCOPIC AND INTEGRAL RESULTS. Grundl, James A. (National Bureau of Standards, Washington, D. C.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

Certain integral measurements performed with pure fission neutrons and with macroscopic systems that are dominated by the fission spectrum identify an important area of disagreement with differential microscopic data. The classic measured value for the ^{238}U average fission cross section for ^{235}U thermal-neutron-induced fission neutrons is $\overline{\sigma}_f(\chi_{25},{}^{238}\mathrm{U}) = 310 \pm 4$ mb and is in serious disagreement with predicted values that fall between 270 and 282 mb, depending on the choice of ^{238}U fission cross section and fission-spectrum shape. Critical consideration is given to direct absolute determinations of $\overline{\sigma}_f(\chi_{25},{}^{238}\mathrm{U})$ and to indirect values obtained from fission-ratio measurements with activation detectors. The latter substantiate the classic value and also provide a new value for the ^{239}Pu fission spectrum. Equivalent disagreements with prediction occur in the interpretation of fission-ratio measurements performed in ^{235}U and ^{239}Pu metal critical spheres, and, in a related area of measurement, the discrepancy between calculated and measured age-to-indium resonance of fission neutrons in water is in a direction consistent with the fission-spectrum discrepancy. The growing importance of integral measurements for the technology of nuclear energy and the consequent need for fast-neutron standardization to serve it underline the difficulties summarized in this paper. (auth)

53489 (CONF-701002–, pp 437-51) MICROSCOPIC FISSION-NEUTRON-SPECTRA MEASUREMENTS. Wiedling, T. (Aktiebolaget Atomenergi, Studsvik (Sweden)).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

A detailed knowledge of the shape of a fission-neutron spectrum is of great importance in predicting the reactivity of a nuclear reactor. A number of measurements exist of neutron spectra of isotopes fissionable at thermal and fast incident-neutron energies as well as of spontaneously decaying nuclei. However, recent macroscopic measurements of fission-neutron spectra have cast some doubt on the reliability and accuracy of the microscopic measurements made up to now. This review of microscopic measurements is mainly concerned with recent measurements on a number of fissionable isotopes. Some comments are made on the status of the results of published data, on experimental techniques, and on future needs. (auth)

53490 (IAE–1969) URS PROGRAM FOR CALCULATING SLOW NEUTRON SPECTRA BY DIFFERENTIAL EQUATIONS. Fedulov, M. V. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

A program was written in ALGOL-60 and M-20 machine code for approximate calculation of the slow-neutron velocity distribution in an infinite homogeneous medium. The calculation procedure is based on solving a system of two first-order linear differential equations. Thermalization in the zirconium hybrid was investigated as an example. (JPRS)

53491 (JINR–P-3-5902) MAGNETIC SYSTEMS FOR TRANSPORTATION AND ACCUMULATION OF SLOW NEUTRONS. Matora, I. M.; Strelina, O. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1971. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

With the aid of the exact equations of the slow neutron motion in the six-pole magnetic field it is shown that the application of such a field to the transportation and accumulation of the neutrons gives a number of advantages as compared with the fields of other symmetry. The estimates performed show that in a straight horizontal neutron beam tube of the type under consideration the polarized neutron flux of about 10^8 n/sec with $\lambda \geq 4$Å does not depend on the distance from the constructed pulse fast reactor IBR-2, and a ring accumulator can hold up to 10^5 neutrons and keep them during the time of the order of their half-life. The loss of neutrons due to the spin inverting was neglected. (auth)

53492 (ORNL-TM-3518) XCHEKR: MULTIGROUP CROSS-SECTION EDITING AND CHECKING CODE. Burgart, C. E.; Straker, E. A. (Oak Ridge National Lab., Tenn.). 13 Aug 1971. Contract W-7405-eng-26. 35p. Dep. NTIS.

XCHEKR is a multigroup cross-section editing and checking code. Cross sections in either ANISN or DTF–IV format may be read from cards or binary magnetic tape. These cross sections may be neutron only, gamma-ray only, or coupled neutron–gamma-ray with full or partial downscatter and/or upscatter. XCHEKR produces a highly readable edit of the P_0 portion of the cross sections, as well as tables of evaluated angular distributions for each group-to-group transfer. Checks are performed to determine if the Legendre coefficients are possible. (auth)

53493 (TID–25736) CINDA 71: AN INDEX TO THE LITERATURE ON MICROSCOPIC NEUTRON DATA. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut. ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France). International Atomic Energy Agency, Vienna (Austria). Nuclear Data Unit). 1 Jan 1971. 1270p. IAEA $24.00.

CINDA 71 contains bibliographical references to all microscopic neutron data in the CINDA files as of December 31, 1970. It supersedes all previous issues of CINDA. Instructions for the use of CINDA are provided. (J.W.R.)

53494 EVALUATION OF GRAIN SHIELDING FACTORS FOR COATED FUEL PARTICLES. Waelti, P. (Gulf General Atomic

Inc., San Diego, Calif.). Nucl. Sci. Eng.; 45: No. 3, 321-30 (Sep 1971).

The calculation of effective cross sections for materials with grain structure has been investigated. A method is outlined based on Sauer's formalism that is not restricted to loosely packed grains and small ratios of scattering to total cross sections, in contrast to the treatment based on isolated grains reported earlier by Dyos and Pomraning. The method is applicable for GAROL-type resonance calculations, i.e., resonance treatments based on an explicit calculation of the detailed energy spectrum, as well as for reactor cell calculations at thermal energies. As an example, the grain shielding factors for 400-μ ThC_2 grains in a carbon moderator have been calculated as energy-dependent quantities through the 21.8- and 23.5-eV thorium resonances at 300°K. The results are compared with a GAROL reference calculation (set up for the grains) and with the method given by Dyos and Pomraning. The maximum error for the energy-dependent grain shielding factors in the present method is 1.3% compared with 11.3% in the method of Dyos and Pomraning. Application of the present method at thermal energies on 200-μ PuO_2 grains embedded in a carbon moderator yields energy-dependent grain shielding factors that differ by <1% from a $S_8 - P_1$ multigroup reference calculation. (auth)

53495 BEAM ENRICHMENT BY THE MULTILAYERED NEUTRON-REFLECTING CONICAL TUBE. Shimooke, T. (Japan Atomic Energy Research Inst., Tokai). Nucl. Sci. Eng.; 45: No. 2, 117-25(Aug 1971).

A theoretical study is made of the reflection of neutrons by a multilayered conical tube which extends the concept of reflection by a single-layer tube. Such a device is useful for producing an intense neutron beam. Two types of this tube are discussed: One produces a high quality beam of greater intensity than obtainable with a conventional collimator. The study shows that the intensity of the thermal neutron beam is 8 to 30 times as strong as that by simple collimation. The other type is for neutron spot-irradiation and is illustrated by establishing a beam of 6100 n/(cm^2 sec) at a focal point from a source flux of 10^6 n/(cm^2 sec). (auth)

53496 PRODUCTION AND SHIELDING OF 15 MeV NEUTRONS. Broerse, J. J.; Engels, A. C.; Groen, J. S. (Radiobiological Inst. TNO, Netherlands). Eur. J. Cancer; 7: No. 2-3, 105-14(May 1971).

From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

The characteristics of various types of D−T neutron generators are described; and the current status of the development of fast-neutron therapy machines reviewed. For clinical applications, a minimum average yield of 4 × 10^{12} neutrons/sec is required. It is concluded that at present no 15-MeV neutron radiotherapy system can produce this output for a reasonable period of time, e.g., 50 hr. The properties of tritium targets are discussed with respect to the target life time and the radiation hazards. Experimental data are presented on the neutron yield as a function of the energy of the bombarding deuterons and target age. The tritium contents of the oil of the accelerator vacuum pumps and the tritium contents of the gas released at the exhaust opening of the rotary pump were measured. Only a small fraction of the total amount of tritium originally present in the target was expelled through the forepump exhaust. A summary was made of attenuation data for various materials used for shielding 15-MeV neutrons. (auth) (UK)

53497 COLLIMATION OF 14 MeV NEUTRON BEAMS. Greene, D.; Major, D. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Eur. J. Cancer; 7: No. 2-3, 121-7(May 1971).

From Meeting held at the Radiobiological Institute TNO; Rijswijk, Netherlands (22 Jun 1970). See CONF-700655.

Measurements on 14-MeV neutron beams defined by a number of different collimator designs were made. Differences produced in the beam definition, under scattering conditions, were fairly small and limited in their effect by the presence of a large component of scattered radiation outside the main beam, in a phantom. A high proportion of the scattered radiation was gamma-rays. (auth) (UK)

53498 ANALYSIS OF DIFFUSION-LENGTH PROBLEM IN THE PRESENCE OF LARGE ABSORPTION. Singh, Om Pal; (Indian Inst. of Tech., New Delhi); Bansal, N. K.; Ghatak, A. K.; Bhushan, Vidya. J. Nucl. Sci. Technol. (Tokyo); 8: No. 6, 309-13(Jun 1971).

The propagation of a thermal neutron beam into a water assembly containing various concentrations of Cd has been studied by solving the diffusion equation in the multigroup formalism. The Nelkin model has been used for the scattering kernel. It is observed that for very high Cd concentrations the experimentalist measures a pseudomode which dominates at small distances from the source. This pseudomode decays very slowly to reach the asymptotic distribution at very large distances from the thermal neutron source and at such large distances the neutron density would become so small that it would be difficult to detect these neutrons. (auth)

53499 COLD NEUTRON EFFECT IN NEUTRON WAVE PROPAGATION. EXPERIMENT IN THE LEAD SYSTEM. Takahashi, Akito (Osaka Univ., Suita, Japan). Nippon Genshiryoku Gakkai Rochuseishi Kenkyu Senmon Iinkai Hokoku; No. 27, 1-23(Mar 1970). (In Japanese).

Many theoretical works have been done on the eigenvalue problems of neutron propagation in crystalline moderators. This paper concerns the behavior of the propagating wave in the crystalline media like lead, in which discrete eigenvalues are not expected, the theoretical and experimental analyses of interference phenomena in the pulse transport experiment of graphite system, and so on. An approximate formula of pulse form was obtained as a function of space and time. The effect of scattering kernel was discussed. An experiment was carried out with the system of a square pillar of lead (99.99%), the dimensions of which were 30 × 30 × 70 cm. A neutron pulse with 85 μs pulse width and 230 Hz of repetition rate were employed. The background due to epithermal neutrons, which was considerable in graphite system, was negligible in the lead system. The measurement of pulse propagation wave form was done at every 1.5 cm interval. The result was compared with that of graphite system. The peak of the wave form was round in the lead system, whereas it was sharp in the graphite system. This fact was qualitatively explained by the calculation of three groups. It was also found that the variation of neutron spectra with position and time was large, and that the effect of diffusion cooling was also large. (Japan)

53500 NEUTRON WAVE PROPAGATION IN FINITE CRYSTALLINE MEDIA. Nishina, Kojiro (Nagoya Univ., Japan). Nippon Genshiryoku Gakkai Rochuseishi Kenkyu Senmon Iinkai Hokoku; No. 27, 1-23(Mar 1970). (In Japanese).

The solutions of neutron wave density in finite crystalline media were derived by using Watson transformations, Laplace transformations, or Poisson's sum formula, and numerical calculations were carried out to obtain detector response and to analyze experimental results. From the obtained expression, various decaying modes were calculated for a 100 cm thick graphite slab, in which the position of poles and cuts was taken into consideration. Dispersion relations were investigated, and the maximum frequency was obtained. The result of a resonance experiment was analyzed with these solutions. The result showed that the frequency of resonance was higher by 300 cps than the experimental value. The reason for this discrepancy was not clear. The observed minimum was also a little different from the calculated value, and the detector size was responsible for this fact. Finally, it was found that the three methods were equivalent, and the choice depends on the purpose of analysis, the size of medium, detector size, and so on. (Japan)

53501 NEUTRON SPECTRA AND THE RESULTING FLUENCE-KERMA CONVERSIONS FOR ^{241}Am–Li (α,n) AND ^{210}Po–Li (α,n) SOURCES. Geiger, K. W.; Van Der Zwan, L. (National Research Council of Canada, Ottawa). Health Phys.; 21: No. 1, 120-3(Jul 1971).

Differential ^{7}Li(α,n)^{10}B cross sections were determined, and from these data, neutron spectra were calculated for ^{241}Am−Li H(α,n) and ^{210}Po−Li H(α,n) sources over the energy range 0−5 MeV. The results are tabulated, together with the conversion from fluence to kerma in wet tissue. (UK)

53502 CORRECTION OF THE FINITE VOLUME OF SCATTERER EFFECT ON THE MEASUREMENT OF DIFFERENTIAL ELASTIC AND INELASTIC NEUTRON CROSS SECTIONS. PART III. EXECUTION OF THE CORRECTIONS. Hermsdorf, D.; Hoehn, J.; Seeliger, D. (Technische Univ., Dresden). Kernenergie; 13: 324-9(Oct 1970). (In German).

Mathematically treated are the following problems: correction of the multiple scattering effect on the measured differential elastic cross section of neutrons; examples for the correction of multiple elastic scattering; correction of the multiple scattering effect on the differential cross section for inelastic scattering; examples for correction of the inelastic differential cross section; and inclusion of absorption during multiple scattering. At the present time, a Monte Carlo method is being developed for multiple scattering effects on inelastic scattered neutrons that cannot be subdivided into various groups according to energy. (H.B.G.)

53503 DEVICE FOR THE MONOCHROMATIZING OF SLOW NEUTRONS. Ruchkov, V. E.; Konstantinov, A. P.; Solov'ev,

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S. P.; Kukhto, O. L. Russian Patent 252,491. 10 Nov 1970. Filed 2 Apr 1965. (In Russian).

The device contains a crystal monochromator, an exit collimator for the neutron beam, and a support for the sample being studied. The device is designed to produce a continuous, monoenergetic beam of neutrons incident on the same point of the sample, regardless of energy fluctuations in the incoming neutron beam. (R.W.R.)

53504 SLOW-NEUTRON SCATTERING BY LIGHT AND HEAVY WATER. Gotoh, Yorio (Japan Atomic Energy Research Inst., Tokai; Takahashi, Hiroshi. Nucl. Sci. Eng.; 45: No. 2, 126-40(Aug 1971).

Since the model in which the water molecules form partially "ice-like" clusters explains the thermodynamic properties, the so-called itinerant oscillator model is applied to the motion of water molecules. The assumption is made that the atoms in a molecule receive stochastic forces from the neighboring molecules. The model of water with the stochastic force, of which the correlation functions are a delta function and a simple exponential, is discussed. The generalized frequency distributions of light and heavy water are derived from the model. The incoherent calculations of scattering laws of light and heavy water are compared with measurements. The model predicts well the total scattering cross section of light water, but the average cosine of scattering angle is slightly higher than that of the experiment. Further refinements in the model are discussed. (auth)

53505 TWO-DIMENSIONAL NEUTRON TRANSPORT IN A QUARTER SPACE. Sanchez-Gutierrez, Julian. Los Angeles; Univ. of California (1970). 118p. University Microfilms Order No. 71-14,008.

Thesis.

The two dimensional quarter-space problem of neutron transport theory is considered by using the Fourier transformation. Starting from the time independent integro-differential form of the Boltzmann Equation, a functional relation for the transform of the neutron density is developed. The introduction of the restrictions of the neutron density to the four quarter-spaces yields a functional relation between their transforms and three different approaches for the determination of the transform of the neutron density in the quarter-space are given. The use of the Bochner's decomposition translates the problem of the determination of the transform of the neutron density in the quarter-space into the solution of a singular integral equation. An iterative scheme for the solution of this integral equation is given and its convergence is proven. The interpretation of the functional relation between the transforms of the restrictions of the neutron density as a Hilbert boundary value problem yields an integral equation for the density of a Cauchy type integral over the real axes (in two complex variables) which defines a sectionally analytic function of two complex variables. The four components of this sectionally analytic function are (except for the signs in two of them) the transforms of the restrictions of the neutron density. An iterative procedure for the solution of the singular integral equation satisfied by the kernel is given and its convergence is proven. An explicit comparison of the two iterative procedures mentioned above is given and, by specializing the source and making several approximations in the evaluation of some integrals, the first order iterate of the neutron density at the edges of the quarter-space is found. By exploiting the structure of the dispersion function appearing in the functional relation satisfied by the transforms of the restrictions of the neutron density, the Hilbert boundary value problem in two complex variables is solved in closed form. This makes it possible to give the transform of the neutron density in the quarter-space in an explicit form, which involves a finite number of integrals of known functions. A comparison with a recent work on the same problem is effectuated and suggestions are given for the application of the procedures followed to other two dimensional problems. (Diss. Abstr. Int., B)

53506 SOURCES OF POLARIZED FAST NEUTRONS. Walter, Richard L. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.). pp 317-49 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug–Sep 1970). See COO-7-593; CONF-700811.

Methods for obtaining polarized neutrons, including some of the current best sources and some promising sources for the future are discussed. The methods include nuclear reactions using unpolarized incident beams, polarization transfer reactions, and small-angle scattering. The advantages and disadvantages of each method are described. (84 references) (J.W.R.)

53507 PRODUCTION OF POLARIZED NEUTRON BEAMS FROM THE D(d,n)^{3}He AND T(d,n)^{4}He REACTIONS USING THE ASSOCIATED PARTICLE METHOD. Schuster, D. G.; Hagengruber, R. L. (Univ. of Wisconsin, Madison). pp 865-7 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug–Sep 1970). See COO-7-593; CONF-700811.

53508 POLARIZED NEUTRON SOURCE USING A COMPRESSION IONIZER. Delpierre, P.; Sene, R.; Kahane, J.; de Billy de Crespin, M. (College de France, Paris). pp 868-70 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug–Sep 1970). See COO-7-593; CONF-700811.

53509 UNDERGROUND NUCLEAR EXPLOSION AS A POLARIZED NEUTRON SOURCE. Keyworth, G. A.; Lemley, J. R. (Los Alamos Scientific Lab., N. Mex.). pp 873-6 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug–Sep 1970). See COO-7-593; CONF-700811.

Nuclear Properties and Reactions, $A \leq 5$

Refer also to abstracts 52987, 53033, 53493, 53507, 53610, 53611, 53629, 53637, 53644, 53697, 53743, 53788, 53835, 53836, 53851, 53859, and 53865.

53510 (CONF-701002–, pp 42-50) NEUTRON–PROTON TOTAL–CROSS-SECTION MEASUREMENTS, 1.5 TO 27.5 MeV. Davis, J. C. (Wisconsin Univ., Madison).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

Fast-neutron total cross sections of hydrogen have been determined with uncertainties between 0.7 and 1.6% at 27 energies from 1.5 to 27.5 MeV. The measurements were carried out in good geometry with monoenergetic neutron sources and with liquid hydrocarbon samples. (auth)

53511 (CONF-701002–, pp 51-6) MEASUREMENT OF THE NEUTRON–PROTON TOTAL CROSS SECTION BETWEEN 0.5 AND 21 MeV. Langsford, A. (Atomic Energy Research Establishment, Harwell (England)); Clements, P. J. (Oxford Univ. (England)).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The neutron–proton total cross section between 0.5 and 21 MeV was measured with the 48-m time-of-flight spectrometer on the Harwell 2.8-m synchrocyclotron. The neutrons were produced in an evaporation spectrum by the deflection of the 140-MeV internal proton beam onto a tungsten target. The total cross section was determined from the ratio of transmission of pairs of samples containing the same amount of carbon, the samples being toluene (C_7H_8), trimethylpentane (TMP) (C_8H_{18}), and reactor-grade graphite. The results were combined into 17 continuous energy groups; the weighted mean cross section in each group varied in accuracy from 0.2% at 1 MeV to 3% at 20 MeV. From a fit to the data over the energy range 0.5 to approximately 7 MeV, a value of the singlet effective range parameter, r_{os}, of 2.59 ± 0.09 ± 0.05 fermis was obtained. (auth)

53512 (CONF-701002–, pp 57-62) SEARCH FOR STRUCTURE IN THE N–P TOTAL CROSS SECTION. Schwartz, R. B.; Schrack, R. A.; Heaton II, H. T. (National Bureau of Standards, Washington, D. C.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

High-precision measurements of the n-p total cross section below 30 MeV show no evidence of any structure. A careful measurement of the differential scattering cross section also shows no evidence of any anisotropy. (auth)

53513 (CONF-701002–, pp 63-73) ANGULAR DISTRIBUTION OF 29-MeV NEUTRONS SCATTERED BY PROTONS. Burrows, Thomas W. (Wisconsin Univ., Madison).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

Proton-recoil spectra from n-p elastic scattering were measured with a counter telescope for an incident neutron energy of 29.0 MeV at mean laboratory proton-recoil angles of 9.4°, 17.6°, 31.1°, and 45.6°, corresponding to center-of-mass neutron scattering angles of 161°, 145°, 117°, and 91.3°, respectively. The ratio $\sigma(161^\circ)/\sigma(91.3^\circ)$ was 1.201 ± 0.025 where the uncertainty quoted was based on counting statistics only. The center-of-mass relative angular distribution was normalized to a total cross section of 317.7 ± 3.2 mg with $A(1 + B \cos^2 \theta)$, $A_1(1 - B_1 \cos \theta + B_1 \cos^2 \theta)$, and $A_2[1 - (B_2/2) \cos \theta + B_2 \cos^2 \theta]$ fits. The preliminary results were $A = 22.4 \pm 0.7$ mb/sr, $B = 0.260 \pm 0.062$, $A_1 = 23.6 \pm 0.8$ mb/sr, $B_1 = 0.143 \pm 0.009$, $A_2 = 23.1 \pm 0.08$ mb/sr, and $B_2 = 0.189 \pm 0.007$, where the uncertainties quoted were based on counting statistics and the error in the total cross section. (auth)

53514 (CONF-701002–, pp 74-9) REVIEW OF ^{3}He(n,p)T REACTION. Costello, Donald G. (Gulf General Atomic, Inc., San Diego, Calif.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

Experimental measurements concerning the ^{3}He(n,p)T reaction are reviewed. In the past there has been a discrepancy between measurements of the n-p reaction based on indirect measurements from the inverse reaction, T(p,n)^{3}He, and those based on direct measurements by ^{3}He proportional counters. Some recent data are presented which resolve this disagreement. The cross section is estimated to be known to 0.2% (1 eV), 1% (1 keV), 3% (10 keV), and 10% (>100 keV). (auth)

53515 (COO-1120-128) REALISTIC AND EFFECTIVE INTERACTIONS IN LIGHT NUCLEI. II. SELF-CONSISTENT CALCULATION OF THE G-MATRIX WITH HARD CORE POTENTIALS. Tripathi, Ram K.; Goldhammer, Paul (Kansas Univ., Lawrence. Nuclear Structure Lab.). [1970]. Contract AT(11-1)-1120. 45p. Dep. NTIS.

Brueckner self-consistent calculations are performed for ^{16}O, ^{3}H, and ^{4}He nuclei, with various modern hard-core interactions. Elements of the G matrix are calculated by the reference-spectrum method, while Q-1 corrections are made by matrix inversion in the proper single-particle space. Thus, it is not assumed that Q commutes with the center-of-mass motion. The prescription for selecting the appropriate spectrum of single-particle excited states is investigated by comparing results of the Brueckner method to other calculations. These comparisons indicate that the particle spectrum should be left unperturbed. One then finds that the Hamada–Johnston, Yale, and Reid (hard-core) interactions yield about one-half the binding energy of ^{16}O. The calculated results are dissected into shell-model components. This analysis indicates that the short-range part of the hard-core interaction is too strongly repulsive. (auth)

53516 (JINR–P1-5893) INVESTIGATION OF THE $\mu^- + {}^{12}C \rightarrow {}^8Li + {}^3He + n + \nu$ REACTION. Batusov, Yu. A.; Bunyatov, S. A.; Gulkanyan, H. R.; Kurz, N.; Sidorov, V. M.; Chernev, Ch. M.; Eramzhyan, R. A.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The capture of μ^--mesons by carbon, nitrogen and oxygen nuclei with the production of the ^{8}Li nuclei was studied using the photoemulsions. The relative probabilities of the possible reaction channels were measured. It is shown that the main channel is the capture of μ^--mesons by the ^{12}C nuclei over the reaction $\mu + {}^{12}C \rightarrow {}^8Li + {}^3He + n + \nu$ with the relative probability within $(1.1 \pm 0.2) \cdot 10^{-3} < W < (1.6 \pm 0.2) \cdot 10^{-3}$. The energy spectra and angular correlations of secondary particles of this channel are compared with the calculations made according to the scheme of the resonance capture of μ^--mesons and the capture by few-nucleon associations. (auth)

53517 (LNF–71/23) TWO BODY PHOTODISINTEGRATION OF ^{3}He WITH LINEARLY POLARIZED GAMMA RAYS. Fabbri, F. L.; Picozza, P.; Schaerf, C. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 11 May 1971. 4p. Dep. NTIS (U. S. Sales Only).

The asymmetry parameter for the reaction $\gamma + {}^3He \rightarrow p + d$ at 90° cms was measured at gamma energies between 180 and 300 MeV. An experimental electric dipole cross section is calculated from these results. (R.W.R.)

53518 (SRO–474-2) FEASIBILITY OF OBSERVING INVERSE BETA DECAY BY DIRECT COINCIDENCE TECHNIQUES. Final Report. Avignone III, F. T.; Darden III, C. W. (South Carolina Univ., Columbia. Dept. of Physics and Astronomy). [1971]. Contract AT(38-1)-474. 37p. Dep. NTIS.

The investigation was a study to determine whether or not reactions of the general form $\bar{\nu}_e + {}^AX_z \rightarrow e^+ + {}^AX_{z-1}$ can be identified by detecting only the two annihilation γ rays from the subsequent reaction $e^+ + e^- \rightarrow 2\gamma$, and the pulse in a target scintillator caused by the slowing of the positron. The results of the experiments indicate that such experiments are very probably feasible if performed inside a cosmic ray live shield. It is estimated, from the data, that (~80 to 100) per cent of the background events are in prompt coincidence with cosmic-ray muons entering into the shielded target region. This discovery was made using a partial cosmic ray live shield located on top of the lead- and boron-loaded polyethylene-shielded target region. A more accurate statement of feasibility would be possible only after further study involving a live shield placed outside the γ-ray and neutron shielding, the live shield covering the top and sides of the shielded region. An unsuccessful attempt to measure the cross section for above reaction, when ^AX_z is a proton, was made by the method mentioned above. (auth)

53519 TRINUCLEON BOUND STATE PROPERTIES AND FORM FACTORS WITH THE B. K. R. POTENTIAL. Malfliet, R. A. (Univ. of Groningen, Netherlands); Tjon, J. A. Phys. Lett.; 35B: No. 6, 487-9(5 Jul 1971).

The triton binding energy and S′- and D-state probabilities are determined using the B.K.R. potential. With mesonic corrections neglected, the charge and magnetic form factors are computed for ^{3}H and ^{3}He. They show a diffraction minimum at $q^2 = 14.4$ fm^{-2}. (auth)

53520 ^{3}H AND ^{3}He FORM FACTORS WITH THE REID POTENTIAL. Yang, S. N.; Jackson, A. D. (State Univ. of New York, Stony Brook). Phys. Lett.; 36B: No. 1, 1-3(9 Aug 1971).

Electromagnetic form factors for ^{3}H and ^{3}He are calculated with the Reid potential and found to be in agreement with experimental data. (auth)

53521 MICROSCOPICALLY SUBSTANTIATED LOCAL OPTICAL POTENTIAL FOR $\alpha-\alpha$-SCATTERING. Neudatchin, V. G.; Kukulin, V. I. Korotkikh, V. L.; Korennoi, V. P. (Moscow State Univ.). Phys. Lett.; 34B: 581-3(12 Apr 1971).

A deep l-independent local potential of the Woods–Saxon form for the description of the energy dependence of all $\alpha-\alpha$ phase shifts measured is proposed. Wave functions in the $\alpha-\alpha$ overlap region have the oscillator form 4S, 4D,etc. The range of the S-phase shift variation equals 3π. Application of the approach proposed to the ^{16}O–^{16}O and NN-systems is discussed. (auth)

53522 MUON CAPTURE IN ^{11}B. Bernabeu, J. (Univ., Valencia). Nuovo Cim.; 4A: No. 4, 715-30(21 Aug 1971).

The partial-capture rates of muons in ^{11}B going to ^{11}Be(g.s.) and ^{11}Be(320 keV), as well as the hyperfine effect in the transition to ^{11}Be*, are studied. Comparing these results with the beta-decay of ^{11}Be and the electromagnetic transition $^{11}Be^* \rightarrow {}^{11}Be$, some conclusions are derived on the nuclear structure of the bound states of ^{11}Be. Some possible experiences which can give information on the pseudoscalar form factor in weak interactions are also discussed. (auth)

53523 ANOMALIES IN QUASIFREE SCATTERING FROM p + ^{3}He REACTIONS. Slaus, Ivo (Univ. of California, Los Angeles. Inst. Rudjer Boskovic, Zagreb); Epstein, M. B.; Paic, G.; (and others). Phys. Rev. Lett.; 27: No. 11, 751-4(13 Sep 1971).

The reactions ^{3}He(p,pd)p and ^{3}He(p,2p)d were studied at 35 MeV. A dominant feature of these data is p–p and p–d quasi-elastic scattering. A plane-wave impulse approximation gives a qualitative fit to the ^{3}He(p,2p)d data, but fails to explain the ^{3}He(p,pd)p data. Various possible explanations are discussed. (auth)

53524 FINAL-STATE INTERACTIONS IN THE REACTION ^{2}H(p,2p)n. Takeutchi, F.; Sakamoto, Y.; Yuasa, T. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett.; 35B: No. 6, 498-500(5 Jul 1971).

The cross sections for the reaction ^{2}H(p,2p)n are calculated by taking into account final-state interactions including S, P, and D waves for all pairs of outgoing nucleons. The D-state wave functions of the deuteron are also included in the calculation. The angular correlation distributions of the cross sections are compared with data for 156-MeV protons. (auth)

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53525 ^{4}He PHOTOSPLITTING AND TWO-PARTICLE UNITARITY. Gur'ev, V. N. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 13: No. 6, 1219-24(Jun 1971). (In Russian).

Multipole analysis of reactions ^{4}He(γ,p)^{3}H and ^{4}He(γ,n)^{3}He is considered using two-particle unitarity and isotopic phase shifts of the nucleon scattering on nucleus A = 3. The agreement of the phase shift analysis with the experimental estimate of phase differences of the E1 and E2 amplitudes for reaction ^{4}He(γ,p)^{3}H and with the vanishing of the asymmetry coefficient in the photoneutron angular distribution at 28 MeV photon energy in lab. system is studied. The behavior of the recoil proton polarization at an angle of 90° in cms is qualitatively considered. (auth)

53526 ANALYSIS OF REACTIONS ^{3}He(n,n)^{3}He, ^{3}H(p,n)^{3}He, ^{3}H(p,p)^{3}H AT LOW ENERGIES AND ^{4}He LEVELS. Barit, I. Ya.; Sergeev, V. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 13: No. 6, 1230-42(Jun 1971). (In Russian).

Charge-invariant phase-shift analysis of differential cross sections of reactions ^{3}He(n,n)^{3}He, ^{3}H(p,n)^{3}He, ^{3}H(p,p)^{3}H and of neutron polarization in reaction (p,n) is fulfilled at energies corresponding to the ^{4}He nucleus excitation energies from 19.8 up to 23.2 MeV. The contribution from all the states produced at $l \leq 2$ is taken into account. The phase shifts and modula of the S-matrix elements describing experimental data are determined. Particle polarization in pH^3 and nHe^3 scattering is calculated. The results of the analysis make it possible to establish that at ^{4}He excitation energies 20.3, 21.1, and 22.1 MeV there are the levels 0^+, 0^-, and 2^- with T = 0 with single-particle reduced widths and that in the triplet s and d states and in the singlet p state there are no levels with T = 0. (auth)

53527 EXCHANGE MECHANISM CONTRIBUTION TO THE BACKWARD PROTON SCATTERING ON LIGHT NUCLEI AND REACTION d + ^{4}He → ^{3}He + ^{3}H. Kopeliovich, B. Z.; Potashnikova, I. K. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 5, 1032-8(May 1971). (In Russian).

The role of the exchange mechanism in backward proton scattering on ^{4}He and ^{3}He is discussed. The simplest exchange graph for the backward proton scattering on ^{4}He is calculated by means of the wave function of ^{4}He, the parameters of which are fixed by the electron scattering data. A good agreement of the calculations with experiment is obtained. In the energy dependence of cross section of the backward proton scattering by the ^{4}He nuclei a characteristic "dip" at 200 MeV protons is expected. The parameters which determine the behavior of the ^{3}He wave function at small distances are estimated. The reaction d + ^{4}He → ^{3}He + ^{3}H is considered. The connection between its cross section and the cross sections of the backward proton scattering on the ^{3}He and ^{4}He nuclei is obtained assuming that the pole graphs dominate. Experiments for revealing the mechanism responsible for the processes under consideration are proposed. (auth)

53528 BREMSSTRAHLUNG IN PROTON–α-PARTICLE SCATTERING. Woelfli, W.; Hall, J.; Mueller, R. (Eidgenoessische Technische Hochschule, Zurich). Phys. Rev. Lett.; 27: No. 5, 271-3(2 Aug 1971).

An experiment to determine the bremsstrahlung cross section in proton–α-particle scattering was performed for incident proton energies between 7.0 and 12.0 MeV. It was found that, in order to obtain agreement with the measured coplanar values, the theoretical calculation must include the contribution of the so-called "rescattering term." (auth)

53529 THREE-NUCLEON GROUND STATE WAVE FUNCTION. II. THE PROPERTIES OF THE RADIAL PART OF THE WAVE FUNCTION. THE INCLUSION OF THE SOFT CORE. THE ELECTRIC CHARGE FORM FACTOR. THE μ-MESON CAPTURE. Bijedic, N.; Maric, Z.; Zlatarov, V. (Boris Kidric Inst. for Nuclear Science, Belgrade). Fizika (Zagreb); 3: No. 1, 11-28(1971).

Determination of the radial part of the total three-body nuclear wave function, which depends on the symmetric scalar argument, is discussed. The complete soft core is included in the known Irving–Gunn radial function. With this function electric-charge form factors for the ^{3}H and ^{3}He nuclei are calculated using different percentages of the S, S′, and D components; the dependence of the single-nucleon charge form factor on the momentum transfer is also found. Comparison with the experimental results is discussed. With the same function μ-meson capture by the ^{3}He nucleus is calculated using the nonrelativistic limit of V–A theory. The usually accepted percentages of S, S′, and D states give very good agreement with the experiment. (auth)

53530 POLARIZATION IN THE SCATTERING OF 16.2-MeV NEUTRONS BY PROTONS. Garrett, R.; Chisholm, A.; Duder, J. C.; Brown, D.; Buergisser, H. N. (Univ. of Auckland, N. Z.). pp 427-9 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53531 POLARIZATION IN NEUTRON–PROTON SCATTERING AT 21.6 MeV. Brooks, F. D.; Jones, D. T. L. (Univ. of Cape Town). pp 430-2 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53532 POLARIZATION IN NEUTRON–PROTON SCATTERING USING 32-MeV POLARIZED NEUTRONS FROM THE D–T REACTION. Ryu, N.; Sanada, J.; Hasai, H.; (and others) (Hiroshima Univ.). pp 433-4 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53533 POLARIZATION IN PROTON–PROTON SCATTERING BETWEEN 30 AND 50 MeV. Arvieux, J.; Darves-Blanc, R.; Durand, J. L.; (and others) (Institut des Sciences Nucleaires, Grenoble, France). pp 435-6 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53534 90^0 POLARIZATION OF PHOTONEUTRONS FROM DEUTERIUM AT PHOTON ENERGIES BETWEEN 5 AND 40 MeV. Nath, R. (Yale Univ., New Haven); Cole, G. W. Jr.; Firk, F. W. K.; Wu, C.-P.; Berman, B. L. pp 437-8 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53535 PROPOSED POLARIZED-TARGET-BEAM TEST FOR $^3S_1$–$^3S_1$ RADIATIVE TRANSITIONS IN THERMAL n–p CAPTURE. Breit, G.; Rustgi, M. L. (State Univ. of New York, Buffalo). pp 439-41 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53536 MEASUREMENT OF THE ANALYZING POWER OF DEUTERIUM FOR 7.89-MeV NEUTRONS AND PHASE-SHIFT ANALYSIS FOR THE n–d DATA BETWEEN 1 AND 10 MeV. Bruening, R. (Institut fuer Experimentalphysik, Hamburg); Zeitnitz, B.; Arvieux, J. pp 445-7 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53537 ANGULAR DEPENDENCE OF NEUTRON POLARIZATION IN n–d ELASTIC SCATTERING AT 2.6 MeV. Jaccard, S.; Piffaretti, J.; Viennet, R.; Weber, J. (Univ., Neuchatel, Switzerland). pp 448-9 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53538 POLARIZATION IN NUCLEON–DEUTERON SCATTERING AT MEDIUM ENERGIES. Franco, V. (Brooklyn Coll. Los Alamos Scientific Lab., N. Mex.). pp 450-2 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53539 MEASUREMENT OF THE TENSOR MOMENTS (iT_{11}), (T_{20}), (T_{21}), (T_{22}) IN THE ELASTIC SCATTERING OF POLARIZED

DEUTERONS BY PROTONS. White, R. E.; Grueebler, W.; Risler, R.; (and others) (Eidgenoessische Technische Hochschule, Zurich). pp 453-4 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53540 MEASUREMENTS OF TRIPLE SCATTERING PARAMETERS IN PROTON–DEUTERON ELASTIC SCATTERING AT 50 MeV. Stewart, N. M. (King's Coll., London); Gibson, W. R. pp 455-6 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53541 DWBA TREATMENT OF THE d + d REACTION AT LOW ENERGIES. Duder, J. C.; Glavish, H. F.; Ratcliff, R. (Univ. of Auckland, N. Z.). pp 459-61 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53542 POLARIZATION OF NEUTRONS FROM THE D(d,n)^{3}He REACTION FROM 6 TO 14 MeV. Spalek, G.; Taylor, J.; Hardekopf, R. A.; Stammbach, Th.; Walter, R. L. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.). pp 462-4 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 52987, 52993, 53019, 53033, 53240, 53485, 53493, 53501, 53515, 53518, 53589, 53664, 53681-53683, 53697, 53722, 53747, 53752, 53788, 53851, 53866, 53877, and 53878.

53591 (CONF-701002-, pp 80-106) REVIEW OF THE DATA ON THE ^{6}Li CROSS SECTIONS BELOW 1.7 MeV. Uttley, C. A.; Sowerby, M. G.; Patrick, B. H.; Rae, E. R. (Atomic Energy Research Establishment, Harwell (England)).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The data on the total, n-α, n-n, and n-γ cross sections of ^{6}Li below a neutron energy of 1.7 MeV are reviewed. The data on the differential (n,α) and (n,n) reactions have not been considered, but particular emphasis has been placed on obtaining the variation

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of the n-α cross section with neutron energy. The best values of this cross section are indicated, and it is estimated that the values are known (one standard deviation) to ±0.5% at thermal energies, ±1% from thermal to 10 keV, ±2% at 100 keV, ±5% from 150 to 300 keV, ±10% at 500 keV, ±15% from 700 to 1000 keV, and ±10% at 1.7 MeV. (auth)

53592 (CONF-701002–, pp 107-20) STUDY OF ^{10}B CROSS SECTIONS. Lane, R. O.; Hausladen, S. L. (Ohio Univ., Athens); Monahan, J. E. (Argonne National Lab., Ill.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

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The results of most of the neutron-scattering, polarization, n-α reactions, total cross section and other related reactions leading to states in ^{11}B that are observed in ^{10}B + n have been interpreted in one consistent R-matrix calculation for neutron energies up to $E_n \simeq 2$ MeV. The calculated results are in good agreement with most of these data, including elastic and inelastic alpha scattering from ^7Li. Furthermore, both the level parameters and calculated reaction results in ^{11}B are consistent with corresponding mirror quantities in ^{11}C. A quantitative explanation of the well-known large 1/v $^{10}B(n,\alpha)^7Li$ cross section, as well as the α_0/α_1 branching ratio, is given. (auth)

53593 (CONF-701002–, pp 121-4) PRELIMINARY MEASUREMENTS OF THE RELATIVE $^6Li(n,\alpha)$ CROSS SECTION. Coates, M. S.; Hunt, G. J.; Uttley, C. A. (Atomic Energy Research Establishment, Harwell (England)).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

Preliminary measurements of the $^6Li(n,\alpha)$ cross section in the energy range 1.5 to $\gtrsim$700 keV have been made with thin lithium glass scintillation detectors on the 45-MeV electron linac booster spectrometer at Harwell. The flux was measured with a new flat-response detector whose detection efficiency has been calculated by a Monte Carlo method to an accuracy of 1 to 2% over the energy region 10 eV to >700 keV. (auth)

53594 (CONF-701002–, pp 125-8) THERMAL CROSS SECTION OF $^6Li(n,\alpha)$ AND RATIO OF $^{10}B(n,\alpha)$ TO $^6Li(n,\alpha)$. Becker, W.; Deruytter, A. J.; Wartena, J. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

Transmission experiments were performed with a known (previously measured) neutron beam on quartz cells filled with helium (blank), D_2O, a solution of $^6Li_2SO_4$ in D_2O, and a solution of natural Li_2SO_4 in D_2O. From the transmission values for the enriched solution, a preliminary result was calculated for the ^6Li absorption cross section of 944 b with an accuracy of only a few percent. This result will be improved considerably by making time-of-flight experiments and by more precise measurements of the ^6Li content. Trial experiments to determine the ratio of $^{10}B(n,\alpha)$ to $^6Li(n,\alpha)$ cross sections up to 30 keV are briefly discussed. (auth)

53595 (CONF-701002–, pp 129-35) THERMAL CAPTURE CROSS SECTIONS OF ^6Li AND ^{10}B BY THE PULSED NEUTRON METHOD. Meadows, J. W. (Argonne National Lab., Ill.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The pulsed-neutron method was used to measure the thermal-neutron capture cross sections of ^6Li and ^{10}B. An analysis of the errors yielded an uncertainty of 0.3%, but the consistency of the results indicated a larger value. The final capture cross sections, evaluated at 2200 m/sec, were 936 ± 4 b for ^6Li and 3842 ± 18 b for ^{10}B. (auth)

53596 (CONF-701002–, pp 136-40) STUDY OF THE PARASITIC EFFECTS IN CROSS-SECTION MEASUREMENTS OF $^6Li(n,\alpha)T$. Filippi, G.; Fort, E.; Le Rigoleur, C.; Leroy, J. L. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

Several investigators have measured the $^6Li(n,\alpha)T$ cross section in the 10- to 600-keV energy region by comparing results obtained with a flux of monochromatic neutrons incident on a "long counter" and those obtained with a detector containing ^6Li. This paper shows that such a comparison can be subject to rather severe error because of neutron scattering in the target-supporting material associated with the resonance at 250 keV in the $^6Li(n,\alpha)T$ reaction. This effect has been studied in detail with time-of-flight methods, and the experimental results are in good agreement with theoretical evaluations obtained from Monte Carlo calculations. (auth)

53597 (CONF-701002–, pp 141-50) $^{10}B(n,\alpha\gamma)$ CROSS SECTIONS. Tucker, W. E.; Nellis, D. O. (Nuclear-Chicago Corp., Austin, Tex. Texas Nuclear Div.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

Cross sections for the production of gamma rays by neutron bombardment of ^{10}B have been measured between 45 keV and 5 MeV and at 14.8 MeV. The results of the measurements of the 478-keV gamma ray from the $^{10}B(n,\alpha)^7Li$ reaction are emphasized. The $^{10}B(n,\alpha_1)^7Li^*$ cross section showed a departure from 1/v dependence above a neutron energy of 100 keV. (auth)

53598 (CONF-701002–, pp 151-65) RECOMMENDED VALUES OF THE $^{10}B(n,\alpha)$ CROSS SECTION BELOW 200 keV. Sowerby, M. G.; Patrick, B. H.; Uttley, C. A.; Diment, K. M. (Atomic Energy Research Establishment, Harwell (England)).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The energy variation of the $^{10}B(n,\alpha)$ cross section below 200 keV has been investigated in two ways: first, by subtracting measurements of the scattering cross section from the total cross section and, second, by measuring the ratio of the $^{10}B(n,\alpha)$ and $^6Li(n,\alpha)$ cross sections in the same neutron spectrum on the Harwell 45-MeV electron linear accelerator. In the second method a recent calculation of the $^6Li(n,\alpha)$ cross section, determined largely from a measurement of the total cross section, was used in conjunction with the ratio measurements to obtain the $^{10}B(n,\alpha)$ cross section. The data are all consistent with the $^{10}B(n,\alpha)$ cross section falling below the $1/\sqrt{E}$ level, reaching a minimum at approximately 25 keV, where the deviation is about 4%. Above this energy the cross section relative to the $1/\sqrt{E}$ level rises and passes through a resonance at approximately 170 keV. The complete set of data has been fitted by an expression that represents the net effect at low energy of s-states outside the energy region under discussion together with an s-wave resonance at 170 keV. A least-squares fitting procedure was used with five free parameters, two of which are the energy and total width of the resonance. It is concluded that the $^{10}B(n,\alpha)$ cross section up to 200 keV can be represented by $\{\sigma_{n\alpha} = (13.837/\sqrt{E}) - 0.312 - 1.014 \times 10^{-2}\sqrt{E} + (2.809 \times 10^5/\sqrt{E}[(170.3 - E)^2 + 2.243 \times 10^4]) \text{ b}\}$ where E is in thousand electron volts. This expression has an estimated accuracy ranging from approximately 1.5% at low energies to approximately 3% at the high-energy end. (auth)

53599 (CONF-701002–, pp 190-200) MEASUREMENT AND ANALYSIS OF THE TOTAL NEUTRON CROSS SECTION OF CARBON FROM 0.5 TO 30 MeV. Cierjacks, S. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The total neutron cross section of carbon was measured with the time-of-flight spectrometer at the Karlsruhe isochronous cyclotron. Below 2 MeV the total cross section of carbon was analyzed in the framework of s-wave effective-range theory. Between 2 and 6 MeV the total neutron cross section has been analyzed using standard multilevel R-matrix formulas for a single open channel to provide neutron resonance parameters. In the latter region new differential data for carbon from our laboratory have been used to verify the l-values obtained by fitting the resonances in the total neutron cross section. (auth)

53600 (CONF-701002–, pp 201-7) ANALYSIS OF THE TOTAL CROSS SECTION OF CARBON FROM 70 eV TO 1.5 MeV. Uttley, C. A.; Diment, K. M. (Atomic Energy Research Establishment, Harwell (England)).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The total cross section of carbon has been measured between 70 eV and 7 MeV, and therefore the energy range between 1 and 100 keV, where few measurements exist, is covered. The cross section below 100 keV is useful as a standard for scattering-cross-section measurements on linacs; and this was the main purpose of the measurement. The data at higher energies are also useful for comparison with the large number of measurements that now exist above 100 keV, and the cross section over the whole energy range is currently of interest for calculations of the age-to-indium resonance of fission neutrons. The total

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cross section up to 1.5 MeV has been analyzed to determine the reduced neutron width of the bound $\frac{1}{2}^+$ state, which accounts for almost all the cross section, and the small p-wave scattering contribution observed is shown to be in reasonable agreement with differential scattering data. (auth)

53601 (CONF-701002–, pp 208-17) MEASUREMENTS OF NEUTRON ELASTIC SCATTERING FROM CARBON IN THE ENERGY REGION OF 0.50 TO 2.00 MeV. Ahmed, N.; Coppola, M.; Knitter, H.-H. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

Thirty-one differential cross-section angular distributions for the elastic scattering of neutrons from carbon were measured at primary-neutron energies between 0.50 and 2.00 MeV using fast-neutron time-of-flight techniques. The fully corrected points of each angular distribution were fitted with a five-term Legendre polynomial expansion. The B_L coefficients obtained were then fitted with suited functions of the energy to obtain a smooth dependence of the differential neutron-scattering cross sections on the primary-neutron energy using a limited number of parameters. A phase-shift analysis based on the present experimental B_L coefficients was performed. The phase shifts obtained are compared with those predicted by a coupled-channel calculation of ^{12}C neutron scattering and with phase shifts resulting from neutron polarization measurements. (auth)

53602 (CONF-701002–, pp 331-40) INTERPRETATION AND INTERCOMPARISON OF STANDARD CROSS SECTIONS. Poenitz, W. P. (Argonne National Lab., Ill.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

Interpretations of experimental values in data evaluations are critically considered. An evaluation has been carried out to obtain consistent data for $\sigma_\gamma(^{197}Au)$, $\sigma_\gamma(^{238}U)$, $\sigma_\alpha(^6Li)$, and $\sigma_f(^{235}U)$. The experimental data fit well with the exception of $\sigma_f(^{235}U)$, where the agreement with experimental data is marginal. (auth)

53603 (CONF-701002–, pp 452-64) PRESENT MEASUREMENTS OF THE ^7Be BRANCHING RATIO. Mutterer, M. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The $4\pi\,\beta\,\gamma$ coincidence measurements that are actually being made at the Central Bureau for Nuclear Measurements to determine a precise value of the ^7Be branching ratio are briefly described. The influence of second-order effects, such as Internal Bremsstrahlung, Internal Ionization, and ^7Li recoils, is discussed. Internal Bremsstrahlung spectra for both branches in the ^7Be decay have been calculated following the theory of Martin and Glauber. Theoretical electron spectra due to the Internal Ionization process have been computed. A spectrum measured with a proportional counter is in fair agreement with the theories of Primakoff and Porter and Intemann in the energy interval from 1 to 4 keV; the theory of Stephas yields values higher by one order of magnitude. Electron spectroscopy in the electron-volt energy region with a retarding-field-type spectrometer shows that nearly all electrons leaving our ^7Be sources are slow secondary electrons with energies lower than about 5 eV. The fractional part of the ^7Li Auger electrons retaining their original energy of about 45 eV after leaving the source is extremely small. All investigations are being continued, and all results reported are only preliminary ones. (auth)

53604 (COO–1120-113) REALISTIC AND EFFECTIVE INTERACTIONS IN LIGHT NUCLEI. I. PARAMETERS OF THE 1p-SHELL. Norton, John L.; Goldhammer, Paul (Kansas Univ., Lawrence. Nuclear Structure Lab.). [1969]. Contract AT(11-1)-1120. 47p. Dep. NTIS.

An intensive study is made of the shell-model effective interaction in the 1p shell, with particular emphasis on determining the importance of high-order G-matrix diagrams. Forty-nine levels, with principal configuration $(1s)^4(1p)^{A-4}$, are used to fit the interaction parameters. Feingold's three-body vector interaction, arising from second-order effects of the tensor force, is verified to be manifestly important in this fit. A simple four-body interaction, designed to simulate α clustering, is also tested. The best fit obtained yields a root-mean-square deviation from experiment of 270 keV. (auth)

53605 (COO-1120-120) GAMMA DECAYS OF THE FIRST TWO T = 3/2 STATES OF ^{15}N. Kuan, H. M.; Umbarger, C. J.; Shirk, D. G. (Kansas Univ., Lawrence. Nuclear Structure Lab.). [1970]. Contract AT(11-1)-1120. 23p. Dep. NTIS.

Gamma transitions from the first two T = 3/2 states of ^{15}N were studied via the reaction $^{14}C(p,\gamma)^{15}N$. The angular distributions of the three transitions from the lowest T = 3/2 state at $E_x = 11.61$ MeV are isotropic, in agreement with the $J^\pi = 1/2^+$ assignment for the state. For the second T = 3/2 state at $E_x = 12.52$ MeV the angular distributions are in agreement with $J^\pi = 5/2^+$. The transitions 12.52 → 5.27 and 12.52 → 6.33 MeV are essentially pure M1 and pure E1, respectively. A comparison of the strength of the allowed β^- decay of the ^{15}C ground state (the supposed parent analog state of the 11.61-MeV state of ^{15}N) to the 5.30-MeV state of ^{15}N with the strength of the 11.61 → 5.30 MeV gamma transition in ^{15}N suggests a considerable contribution from the orbital part in the M1 matrix element. The Zuker–Buck–McGrory shell-model wave functions for ^{15}N give a qualitative description of the observed γ decay, but the disagreement in decay strengths between theory and experiment and the omission of the known $1P_{1/2}$ hole state (6.33 MeV) suggest the need of ^{12}C core excitation in the ZBM calculation. (auth)

53606 (COO–1120-130) CALCULATION OF ISOSPIN MIXING IN ^8Be WITH CORRELATED WAVEFUNCTIONS. Anderson, R. K.; Goldhammer, Paul (Kansas Univ., Lawrence. Dept. of Physics). [1970]. 8p. Dep. NTIS.

Isospin mixing in the 2^+, 1^+, and 3^+ states of ^8Be is calculated with correlated radial wavefunctions obtained from reference-spectrum solutions of the Bethe–Goldstone equation. The off-diagonal matrix elements are approximately a factor of two larger than those calculated with oscillator wavefunctions and provide a very reasonable interpretation of the experimental data. (auth)

53607 (JINR–P2-5861) TRANSITION TOROIDAL FORM FACTORS OF LIGHT NUCLEI. Bluvshtein, R. E.; Dubovik, V. M.; Cheshkov, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 25p. (In Russian). Dep. NTIS (U. S. Sales Only).

In the long-wave approximation the transverse electrical multipole form factors (f.f.) $E_1(-k^2)$ are usually replaced by the charge f.f. $Q_1(-k^2)$. In reality $E_1(-k^2)$ have the exact form $E_1(-k^2) = \omega Q_1(-k^2) + k^2T_1(-k^2)$, where $T_1(-k^2)$ are the independent f.f. corresponding to static moments with special physical properties and are called toroidal. The transition of the nucleus ^9Be $J^P = \frac{3}{2}^- \rightarrow \frac{1}{2}^+$, induced by high-energy electrons scattered at large angles is considered. This example shows that the ordinary replacement $E_1 \rightarrow \omega Q_1$ is not justified quantitatively. A set of experiments for separate determination of the f.f. of the transition $\frac{3}{2}^- \rightarrow \frac{1}{2}^+$ is discussed in detail. (R.W.R.)

53608 (NP–18698) LABORATORI NAZIONALI DI LEGNARO (PADOVA) ANNUAL REPORT, 1969. Bizzeti, P. G.; Ricci, R. A.; Vingiani, G. B. (Istituto Nazionale di Fisica Nucleare, Padua (Italy)). 54p. Dep. NTIS (U. S. Sales Only).

CALCIUM-40— alpha reactions (α,γ) at 4.1 to 4.9 MeV, γ spectra from, (E)
CARBON-12—neutron elastic scattering at 1.9 to 5.2 MeV, cross sections and polarization for, (E)
CHLORINE-34—energy levels from phosphorus-31 $(\alpha,n\gamma)$ reactions, lifetimes of low lying, (E)
CHLORINE-35—energy level at 3.16 MeV from sulfur-34 (p,γ) reactions, lifetime of, (E)
HELIUM-3—reactions $(He\text{-}3,\alpha)$ with nitrogen-14 at 5 to 10 MeV, angular distributions and excitation functions for, (E)
LITHIUM-6—neutron elastic scattering at 4.1 MeV, angular distribution and optical-model parameters for, (E/T)
MANGANESE-55—proton reactions (p,n) at 1.3 to 3 MeV, neutron yield from, (E)
NITROGEN-14—helium-3 reactions $(He\text{-}3,\alpha)$ at 5 to 10 MeV, angular distribution and excitation function for, (E)
PHOSPHORUS-30—energy level scheme from silicon-29 (p,γ) reactions, (E)
SCANDIUM-45—energy levels from alpha Coulomb excitation, transition probabilities for, (E)
  —energy-level scheme from proton inelastic scattering, (E)
  —proton inelastic scattering at 2 to 5 MeV, p-γ coincidence spectra from, (E)
TITANIUM-44—energy level scheme from calcium-40 (α,γ) reactions, (E)
TITANIUM-48—proton elastic scattering at 1358 to 1370 keV, excitation function for, (E)
  —proton reactions (p,γ) at 1358 to 1370 keV, excitation function for, (E)
TITANIUM-50—proton elastic scattering at 1363 to 1379 keV, excitation function for, (E)

—proton reactions (p,γ) at 1363 to 1379 keV, excitation function for, (E)
—proton reactions (p,n) at 3.4 to 3.7 MeV, neutron yield from, (E)
—proton elastic scattering at 3.4 to 3.7 MeV, excitation functions for, (E)
VANADIUM-49—energy-level scheme from titanium-49 (p,nγ) reactions, (E)
VANADIUM-50—energy levels from alpha Coulomb excitation, transition probabilities for, (E)
VANADIUM-51—energy levels from alpha Coulomb excitation, transition probabilities for, (E) (J.W.R.)

53609 SUPERALLOWED FERMI DECAY OF ^{14}O AND ITS RELEVANCE TO WEAK INTERACTION THEORY. **Clark, G. J.** (Atomic Energy Research Establishment, Harwell, Eng.); **Freeman, J. M.; Robinson, D. C.; (and others).** Phys. Lett.; 35B: No. 6, 503-6(5 Jul 1971).

A new measurement of the half-life for ^{14}O decay was made, giving the result 70.580 ± 0.035 s. This brings the ft value for the pure Fermi decay of ^{14}O into agreement with the value for ^{26m}Al, and gives support to the recent estimate of a lower limit to the mass of the intermediate vector boson. (auth)

53610 STABILITY OF THE EVEN He-ISOTOPES. **Lombard, R. J.** (Institut de Physique Nucleaire, Orsay, France). Phys. Lett.; 35B: No. 6, 493-4(5 Jul 1971).

The energy-density formalism is used to calculate the total binding energy of the even He isotopes up to mass number 10. The results underline the importance of the symmetry energy and the 1 · s force in determining the stability of these nuclei against particle emission. (auth)

53611 PROJECTED HARTREE-FOCK CALCULATIONS FOR LIGHT NUCLEI WITH PHENOMENOLOGICAL AND REALISTIC EFFECTIVE INTERACTIONS. **Bouten, M.** (International Centre for Theoretical Physics, Trieste, Italy); **Bouten, M. C.; Depuydt, H.; Schotsmans, L.** Phys. Lett.; 35B: No. 6, 464-6 (5 Jul 1971).

Results of PHF calculations, carried out with the phenomenological force B1 of Brink and Boeker [Nucl. Phys., A91: 1(1967)] and with the realistic matrix elements of Faessler, et al. [Nucl. Phys. A155: 465(1967)], are compared; and the differences are analyzed in terms of differences in the oscillator matrix elements of the two potentials. (auth)

53612 ABSOLUTE VECTOR POLARIZATION CALIBRATION IN THE ELASTIC SCATTERING OF DEUTERONS ON CARBON AT MEDIUM ENERGIES. **Seibt, E.; Weddigen, C.** (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Phys. Lett.; 35B: No. 6, 509-11(5 Jul 1971).

At medium energies and under certain circumstances double-scattering experiments can be used for absolute calibration of deuteron vector polarization. By this method the vector polarization (or analyzing power) iT_{11} was calibrated for the elastic scattering of deuterons by carbon at $\theta_{CM} = 39°$ as a function of deuteron energy; iT_{11} was found to be −0.160, −0.171, and −0.198 at 51, 46, and 41 MeV, respectively. The relative experimental errors are 11%. The small energy dependence makes carbon a useful polarizer and analyzer for deuteron vector polarization at medium energies. (auth)

53613 EXACT FINITE-RANGE DWBA ANALYSIS OF MULTI-NUCLEON TRANSFER REACTIONS. **Perrenoud, J.-L.; Devries, R. M.** (Univ. of California, Los Angeles). Phys. Lett.; 36B: No. 1, 18-20(9 Aug 1971).

Exact finite-range DWBA calculations were made both for a (d,p) process and for the reaction ^{9}Be(p,α)^{6}Li. In the case of the single-nucleon stripping, a very good agreement with the zero-range evaluation was found. For the multi-nucleon transfer, however, the exact results exhibit features that cast serious doubt upon the validity of the zero-range approximation. (auth)

53614 ^{16}O FIRST ROTATIONAL BAND FROM THE ^{12}C(^{6}Li, d)^{16}O REACTION. **Bassani, G.; Pappalardo, G.; Saunier, N.; Traore, B. M.** (CEN, Saclay, France). Phys. Lett.; 34B: 612-14(12 Apr 1971).

The most prominent peaks in the ^{12}C(^{6}Li,d)^{16}O spectra at energies up to 32 MeV correspond to levels in ^{16}O at 6.910 ± 0.006 MeV ($J^{\pi} = 2^{+}$), 10.346 ± 0.006 MeV (Γ_{CM} < 50 keV, $J^{\pi} = 4^{+}$), 16.304 ± 0.020 MeV (Γ_{CM} = 360 ± 40 keV) and 20.88 ± 0.06 MeV (Γ_{CM} = 720 ± 100 keV). The last two states are probably the higher members of the first rotational band with $J^{\pi} = 6^{+}$ and 8^{+}, respectively. A comparison with recent theoretical calculations is given. (auth)

53615 21.7 AND 22.1 MeV STATES IN ^{17}O. **Keyser, R. M.; Blue, R. A.; Weller, H. R.** (Univ. of Florida, Gainesville). Phys. Lett.; 34B: 602-4(12 Apr 1971).

Recently reported measurements of the ^{14}C(^{3}He,n)^{16}O and ^{14}C (^{3}He,γ)^{17}O cross sections have shown a strong resonance in ^{17}O at 22.17 ± 0.05 MeV. Detailed measurements of the ^{14}C(^{3}He,α) ^{13}C cross sections indicate that there are two broad levels having J^{π} values of ($5/2^{\pm}$, $7/2^{\pm}$) in this region. With the results of previous γ-ray measurements, the parity ambiguity can be resolved. The assignment was found to be ($5/2^{+}$, $7/2^{-}$). The level at 22.1 MeV appears to be a 3p-2h quasi-bound state. (auth)

53616 MONOPOLE FORM FACTORS AND THE α-CLUSTER MODEL. **Dutta, S.; Tomusiak, E. L.** (Univ. of Saskatchewan, Saskatoon). Phys. Lett.; 35B: No. 7, 554-6(19 Jul 1971).

It is shown that both the ground-state form factor and the inelastic form factor for the $0^{+} \rightarrow 0^{+}$ (6.06-MeV) transition in ^{16}O are well accounted for by the fully antisymmetrized α-cluster model. This model is applied to ^{12}C: the linear-chain intrinsic cluster structure is unable to give both the monopole matrix element and the form factor at higher q. (auth)

53617 DETERMINATION OF THE DEFORMATION IN ^{12}C FROM ELECTRON SCATTERING. **Nakada, A.** (Tohoku Univ., Sendai); **Torizuka, Y.; Horikawa, Y.** Phys. Rev. Lett.; 27: No. 11, 745-8(13 Sep 1971).

The elastic and inelastic form factors for the 0^{+}, 2^{+}, and 4^{+} states in ^{12}C were measured. The data were analyzed by treatment of the rotational excitation in the framework of the Nilsson model. A single intrinsic state that satisfies simultaneously the observed form factors for the intraband transitions was obtained. The deformations were extracted directly from the charge distribution of the intrinsic state. (auth)

53618 FORM FACTORS AT HIGH ENERGIES FOR ^{9}Be NUCLEUS AND SEPARATION OF π-MESON ABSORPTION BY NUCLEON PAIRS IN THE P STATE OF THE RELATIVE MOTION. **Golovanova, N. F.; Neudachin, V. G.** (Moscow State Univ.). Yadern. Fiz.; 13: No. 6, 1248-58(Jun 1971). (In Russian).

The C0, C1, C2, M1, and M3 form factors are calculated for elastic and inelastic electron scattering and quasielastic nucleon knock-out from 1s and 1p states. Nucleon cluster model was used with the wave functions based on the conception of two-center one-nucleon orbitals. The calculated results are in reasonable agreement with experiment. Various π-meson form factors are also calculated. The two-nucleon absorption of the π mesons on the 1s and 1p nucleons in the P state of the relative motion was under particular investigation. The form factors for the relative motion of the nucleon absorbing the π meson are discussed. (auth)

53619 INTENSIVE HIGH-ENERGY NEUTRON FLUXES BY CYCLOTRON BOMBARDMENT OF THICK LITHIUM AND BERYLLIUM TARGETS WITH 22-MeV DEUTERONS. **Daruga, V. K.; Krasnov, N. N.** At. Energ. (USSR); 30: No. 4, 399-400(Apr 1971). (In Russian).

The authors' earlier studies on the angular distribution of neutrons from the d + Li reaction were extended, measuring the absolute neutron yields at all energies in the 0 = 0° direction (with respect to the bombarding 22 ± 1 MeV deuteron beam) from thick lithium, beryllium, niobium, and uranium targets by means of a BF_3 counter. A stilbene scintillation spectrometer was used to measure the neutron spectra. The mean energy data and the estimated neutron yields are tabulated. A ZnS(Ag) + Plexiglas detector was used to measure the Y(0°)/Y(90°) neutron yield ratio at $E_n > 1.8$ MeV and to estimate the angular distribution for $E_n > 4$ MeV. (TTT)

53620 STUDIES OF THE INTERNAL BREMSSTRAHLUNG IN ATOMKI, DEBRECEN. **Varga, D.** ATOMKI (At. Kut. Intez.) Kozlem.; 12: 165-73(Nov 1970). (In Russian).

Study of the internal bremsstrahlung (IB) at the Atomic Research Institute, Debrecen was started in 1962. The annihilation radiation interfered strongly with the measurements and only in 1968 did D. Berenyi and his co-workers succeed in measuring the IB spectrum in the decay of ^{11}C. The following transitions have been studied: ^{11}C (β^{+}), ^{32}P (β^{-}), ^{55}Fe (ϵ), ^{36}Cl (ϵ), ^{143}Pr (β^{-}), ^{204}Tl (β^{-}), ^{54}Mn (ϵ). In the case of ^{11}C, the differential spectrum, i.e., the β^{+}–γ (B) coincidence was measured at an angle of 90°. By carefully chosing the experimental conditions, the effect of the annihilation radiation could be removed. In case of ^{32}P, the absorption method was used, together with the method based on the magnetic deviation of primary electrons. It was found that the external bremsstrahlung could not be completely eliminated; this accounts for the scatter of the experimental results. The theory is able to give the shape of the IB spectrum with a deviation of not more than 15%. No anomalies could be found in the spectrum of ^{36}Cl; earlier anomalies were attributed to the calculation method

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used. ^{143}Pr exhibited an ambiguous first-order, forbidden transition. The differential IB spectrum of ^{204}Tl was found to differ from both permitted and forbidden theoretical curves. The relative intensity of the $(1.9 \pm 0.3) \cdot 10^4$ of ^{54}Mn agrees with the calculated value of $2.0 \cdot 10^4$. Additional details of these studies are presented in a paper by D. Berenyi (Magy. Fiz. Folyoirat, 18: 23(1970)). (TTT)

53621 ENERGY AND ANGULAR DISTRIBUTION OF RECOIL NUCLEI IN THE REACTION $^{12}C(p,pn)^{11}C$. Denisov, F. P.; Bulatov. B. P.; Volkov, A. A.; Dudkin, V. E.; Filin, L. N. Yadern. Fiz.; 13: No. 5, 925-7(May 1971). (In Russian).

Integral energy distributions of the recoil nuclei in the reaction $^{12}C(p,pn)^{11}C$ at the incident proton energy of 660 MeV are measured at the angles of 30, 105, and 135° to the beam direction. The obtained results are in satisfactory agreement with the results calculated by Benioff and Person in the impulse approximation with distorted waves and the exponential radial wave function. (auth)

53622 ~12.6 MeV DEUTERON VECTOR POLARIZATION IN ELASTIC SCATTERING ON ^9Be, ^{11}B, AND Ti NUCLEI. Zaika, N. I.; Kibkalo, Yu. V.; Levshin, E. B.; (and others) (Inst. of Nuclear Research, Kiev). Yadern. Fiz.; 13: No. 5, 928-33(May 1971). (In Russian).

Deuteron polarization angular dependences in the region of 15 to 70° cms are determined from the measurements of the left–right asymmetry in elastic scattering of the vector-polarized deuterons by ^9Be, ^{11}Be, and Ti nuclei. A polarized deuteron beam was obtained in the elastic scattering by C nuclei at angle 25°. The data are compared with the calculations from optical model. (auth)

53623 STUDY OF RESIDUAL INTERACTION ACCOUNTING FOR A LARGE NUMBER OF CONFIGURATIONS. Vinogradov, B. N.; Nemirovskii, P. E. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 13: No. 5, 1016-21(May 1971). (In Russian).

The population number of particle and hole states in ^{16}O, ^{18}O, ^{40}Ca, ^{42}Ca, ^{48}Ca, ^{206}Pb, ^{208}Pb, and ^{210}Pb are calculated by the configuration interaction method. The question of the choice of phenomenological parameters of the residual interaction is discussed. (auth)

53624 POSSIBLE NATURE OF 0^+ LEVELS IN ^{16}O. Afanas'ev, G. N.; Bal'butsev, E. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 5, 1022-5(May 1971). (In Russian).

Monopole excitations in a nucleus generated by fluctuations in the radial mass distribution are investigated. The energy of the vibrations connected with the rms radius fluctuations in ^{16}O is calculated, the result being in agreement with that of the recent estimate by Brueckner. The possibility of explaining in a similar way the 0^+ level at 6.06 MeV in ^{16}O is discussed. (auth)

53625 NARROW STRUCTURE NEAR 39 MeV IN ^{28}Si OBSERVED IN THE REACTION $^{12}C(^{16}O,\alpha)^{24}Mg$. Gastebois, J.; Ballini, R.; Charles, P.; Fernandez, B.; Fouan, J. (CEN, de Saclay, Gif-sur-Yvette, France). Lett. Nuovo Cim.; 2: No. 3, 90-4(17 Jul 1971).

Excitation functions for the reaction $^{12}C(^{16}O,\alpha)^{24}Mg$ were measured at several angles from 45 to 56 MeV. Structures that are relatively narrow and correlated with each other were observed in the excitation functions of the 15.15- and 16.55-MeV states of ^{24}Mg. It is suggested that these are observations of a doorway state consisting of three α particles interacting with an ^{16}O core. This interpretation yields a simple explanation for the selective population of highly excited states of ^{24}Mg by α-particle emission, if these states are of a two-α-cluster type. These data may constitute direct experimental evidence for the extreme case of the quartet model in sd-shell nuclei. (R.W.R.)

53626 POLARIZATION OF NEUTRONS EMITTED FROM THE REACTION $^{12}C(d,n)^{13}N$ UNDER 20^0 LAB. AT 2.75 AND 3.0 MeV. Jaccard, S.; Germond, J.-F.; Piffaretti, J.; Weber, J. (Univ., Neuchatel, Switzerland). Helv. Phys. Acta; 44: No. 4, 502-4(7 Jan 1971). (In French).

As a check of results published earlier and as a test of a liquid He polarimeter, two measurements of the polarization of the neutrons from the $^{12}C(d,n)^{13}N$ reaction at $\bar{E}_d = 2.71$ and 2.96 MeV were performed. Monte Carlo techniques are used for multiple scattering corrections. The results are $P_1 = (-36.5 \pm 2.2)\%$ and $P_1 = (-37.0 \pm 1.8)\%$, respectively, in good agreement with the results of Walter et al. [Phys. Rev., 141: 825 and 150: 821(1966)]. (auth)

53627 REACTION $^{13}C(^3He,\alpha)$ IN THE ENERGY RANGE 1.8 TO 5.4 MeV. Boehle, K.; Meyer, V.; Mueller, H. H. (Univ., Zurich). Helv. Phys. Acta; 44: No. 3, 367-86(15 May 1971). (In German).

Excitation curves in the energy range $E_{^3He} = 1.2$ to 5.4 MeV were measured in steps of 75 keV at $\theta_{lab} = 23$ or 40° and $\theta_{lab} =$ 150 or 157°. In the energy range $E_{^3He} = 2$ to 5 MeV angular distributions for the reaction $^{13}C(^3He,\alpha)^{12}C$ were measured in steps of 140 keV for the alpha particles α_0, α_1, and α_2, which correspond to the ground state and first and second excited states of ^{12}C. Absolute excitation cross sections are given and compared with results of other authors. Compound-nucleus formation is the primary reaction mechanism, which leads to overlapping levels in the ^{16}O nucleus with excitation energies of 24 to 26 MeV. Indications of isolated levels exist for $E_x = 25.3$, 25.6, and 26 MeV. Attempts are made to describe the angular distributions by means of a Hauser–Feshbach calculation as well as through interference between the mechanisms for compound-nucleus formation and direct reactions. (tr-auth)

53628 FORM FACTOR OF ^6Li. Chowdhury, S. M. M. R. (Atomic Energy Centre, Dacca, Pakistan); Afzal, S. A.; Suhrabuddin, S. Nucl. Sci. Appl., Ser. B; 5: 1-3(Oct 1969).

The charge form factor of ^6Li is calculated using the α–d cluster model of ^6Li. The wave functions for the alpha particle and the deuteron, which give correct binding energies and rms radii, are taken as the exponential and Hulthen forms, respectively. The theoretical results obtained with the model agree well with experiment. (auth)

53629 SOME FURTHER COMMENTS ON THE μ CAPTURE MECHANISM. Pratt, T. A. E. C. (Illinois State Univ., Normal). Lett. Nuovo Cim.; 2: No. 1, 1-6(3 Jul 1971).

Several aspects of μ-meson capture are considered. Study of the Doppler effect indicates a two-step process: $\mu^- + (A,Z) \rightarrow (A,Z-1) + \nu$ followed by the decay of the recoiling nucleus $(A,Z-1) \rightarrow (A-1,Z-1) + n + \nu$. Information on neutron decay widths confirms this conclusion. The radiative-capture process resulting in internal bremsstrahlung is also discussed. (R.W.R.)

53630 $^6Li(\vec{d},\alpha)^4He$-REACTION BELOW 1 MeV. Rudin, H.; Huber, P.; Naegele, H. P.; Neff, R.; Seiler, F. (Univ., Basel). pp 595-6 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53631 PROTON POLARIZATIONS FROM $^6Li(^3He,p)^8Be(g.s.)$ AND (f.e.s.) REACTIONS. Simons, D. G. (Naval Ordnance Lab., Silver Spring, Md.). pp 597-8 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53632 REMEASUREMENT OF THE NEUTRON POLARIZATION FROM THE $^7Li(p,n)^7Be$ REACTION FOR 3 TO 4 MeV PROTONS. Hardekopf, R. A. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Walter, R. L.; Joyce, J. M.; Morgan, G. L. pp 599-600 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53633 INVESTIGATION OF THE REACTIONS $^9Be(p,d)^8Be$ AND $^9Be(p,\alpha)^6Li$ WITH POLARIZED AND UNPOLARIZED PROTONS OF 300 TO 1250 keV. Keck, R.; Schober, H.; Jochim, H. P. (Otto-Hahn-Institut, Mainz). pp 601-2 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53634 POLARIZATION OF ^3He SCATTERED FROM ^9Be, ^{12}C, AND ^{16}O AT 18 AND 20 MeV. McEver, W. S. (Univ. of North Carolina, Chapel Hill. Triangle Universities Nuclear Lab., Durham, N. C.); Clegg, T. B.; Joyce, J. M.; Ludwig, E. J.; Walter, R. L. pp 603-5 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

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53635 NEUTRON POLARIZATION FROM THE $^{11}B(\alpha,n)^{14}N$ REACTION AT LOW ENERGIES. Pencea, C.; Salagean, O.; Ciocanel, A.; Molea, M. (Inst. for Atomic Physics, Bucharest). pp 606-8 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53636 POLARIZATION OF 3 TO 7 MeV NEUTRONS SCATTERED FROM ^{12}C. Weil, J. L.; Galati, W. (Univ. of Kentucky, Lexington). pp 609-10 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53637 SCATTERING OF 14-MeV POLARIZED NEUTRONS BY ^{12}C, ^{16}O, AND D. Sene, R.; Delpierre, P.; Kahane, J.; de Billy de Crespin, M. (College de France, Paris). pp 611-14 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53638 EXPERIMENTS ON THE POLARIZATION OF 15-MeV NEUTRONS BY SCATTERING ON LIGHT NUCLEI. Mack, G.; Hentschel, G.; Klein, C.; (and others) (Univ., Tuebingen, Ger.). pp 615-16 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53639 ANALYSES OF PROTON–^{12}C SCATTERING BETWEEN 4.8 AND 8 MeV. Terasawa, T. (Tokyo Univ.); Mikoshiba, O.; Tanifuji, M. pp 617-18 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53640 PROTON POLARIZATION IN THE $^{12}C(^3He,p)^{14}N$(g.s.) REACTION AT ENERGIES BETWEEN 2.4 AND 3.6 MeV AND ANGLES BETWEEN 20^0 AND 75^0. Oehler, H.; Krivopustov, M. I.; Vibike, H. I.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). pp 619-21 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53641 DETERMINATION OF J^π OF STATES IN ^{17}O NEAR 8 MeV EXCITATION ENERGY VIA THE $^{13}C(\alpha,n)^{16}O$ REACTION. Donoghue, T. R.; Busch, C. E.; Keane, J. A.; Paetz gen Schieck, H. (Ohio State Univ., Columbus). pp 622-3 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53642 DIFFERENTIAL POLARIZATIONS OF PHOTONEUTRONS FROM THE GIANT DIPOLE STATES OF ^{16}O. Cole, G. W. Jr.; Firk, F. W. K. (Yale Univ., New Haven). pp 626-7 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53643 POLARIZATION OF 8 TO 12 MeV PROTONS ELASTICALLY SCATTERED BY OXYGEN. Prior, R. M.; Corrigan, K. W.; Darden, S. E. (Univ. of Notre Dame, Ind.). pp 628 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53645 VECTOR POLARIZATION OF ELASTICALLY SCATTERED DEUTERONS. Gofman, Yu. V.; Zaika, N. I.; Kibkalo, Yu. V.; (and others) (Inst. for Nuclear Research, Kiev). pp 673-4 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53646 MICROSCOPIC ANALYSIS OF 30.3-MeV INELASTIC PROTON SCATTERING BY LIGHT NUCLEI. Greaves, P. D.; Hnizdo, V.; Karban, O.; Lowe, J. (Univ. of Birmingham, Eng.). pp 697-9 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53648 ELASTIC AND INELASTIC SCATTERING OF POLARIZED PROTONS ON ^{11}B IN THE GIANT RESONANCE REGION. Salzborn, E.; Clausnitzer, G. (Univ., Giessen, Ger.). pp 703-4 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53649 DEUTERON D-STATE EFFECT IN TENSOR POLARIZATION FOR THE $^9Be(p,d)^8Be$ REACTION. Santos, F. D. (Laboratorio de Fisica e Engenharia Nucleares, Sacavem, Portugal). pp 729-31 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53650 EFFECT OF THE DEUTERON D-STATE ON DWBA CALCULATIONS FOR $^{16}O(p,d)^{15}O$. Delic, G. (Australian National Univ., Canberra). pp 732-3 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53651 POLARIZATION PRODUCED IN THE $^9Be(d,n)$ REACTIONS AT 3.0 AND 3.5 MeV AND A COMPARISON TO DWBA CALCULATIONS. Spalek, G.; Hardekopf, R. A.; Taylor, J.; Stammbach, Th.; Walter, R. L. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.). pp 749-51 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53652 VECTOR ANALYZING POWER OF $l_p = 1$ (d,n) REACTIONS ON B, N, AND Y. Hilscher, D.; Quin, P. A.; Davis, J. C. (Univ. of Wisconsin, Madison). pp 752-3 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53653 CROSS-SECTION AND POLARIZATION MEASUREMENTS FOR THE $^{11}B(d,n_0)$ AND $^{11}B(d,n_1)$ REACTIONS FROM 7 TO 12 MeV. Taylor, J.; Stammbach, Th.; Hardekopf, R. A.; Spalek, G.; Walter, R. L. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.). pp 754-7 of Polarization phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53654 RECENT POLARIZATION MEASUREMENTS PERFORMED IN KRAKOW ON (d,p) STRIPPING REACTIONS. Budzanowski, A.; Freindl, L.; Karcz, W.; (and others) (Inst. of Nuclear Physics, Krakow). pp 767-71 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53655 DIFFERENTIAL CROSS SECTION AND POLARIZATION IN THE $^{12}C(d,p)^{13}C$ g.s. REACTION AT 51 MeV. Fetscher, W.; Sattler, K.; Seibt, E.; Staudt, R.; Weddigen, Ch. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). pp 772-3 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53656 TENSOR ANALYZING POWERS OF THE REACTIONS $^{12}C(d,d)$ AND $^{12}C(d,p)^{13}C$. Debenham, A. A.; Griffith, J. A. R.; Karban, O.; Roman, S.; Takeuchi, Y. (Univ. of Birmingham, Eng.). pp 774-6 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53657 STRIPPING REACTIONS ON NUCLEI IN THE 1p-SHELL INITIATED BY VECTOR POLARIZED DEUTERONS. Fick, D.; Kankowsky, R.; Kilian, K.; Salzborn, E. (Univ., Erlangen, Ger.). pp 788-90 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53658 TWO-NUCLEON TRANSFER REACTIONS INDUCED BY POLARIZED PROTONS. Hardy, J. C.; Bacher, A. D.; Plattner, g. R.; Macdonald, J. A.; Sextro, R. G. (Univ. of California, Berkeley). pp 794-5 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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53659 ASYMMETRIES IN (p,t) AND (p,^{3}He) REACTIONS INDUCED BY 49.5-MeV POLARIZED PROTONS. Nelson, J. M.; Chant, N. S.; Fisher, P. S. (Oxford Univ.). pp 796-7 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53660 REMARKS ON THE MEASUREMENT OF THE POLARIZATION OF ^{6}Li-IONS. Fick, D. (Univ., Erlangen, Ger.). pp 861-2 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

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Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 52987, 52993, 53019, 53021, 53051, 53485, 53493, 53518, 53608, 53611, 53620, 53622, 53623, 53644, 53645, 53647, 53652, 53728, 53743, 53747, 53751, 53752, 53788, 53803, 53809, 53863, 53877, and 53878.

53661 (COO-1120-119) STUDY OF $^{88}Sr(p,\gamma)^{89}Y$ AND $^{89}Y(p,\gamma)^{90}Zr$ FROM E_p = 2.3 TO 3.0 MeV. Umbarger, C. J.; Close, D. A.; Sievers, W. L.; Bearse, R. C. (Kansas Univ., Lawrence. Nuclear Structure Lab.). [1970]. Contract AT(11-1)-1120. 30p. Dep. NTIS.

The $^{88}Sr(p,\gamma)^{89}Y$ and $^{89}Y(p,\gamma)^{90}Zr$ reactions were investigated in the energy range E_p = 2.3 to 3.0 MeV. Excitation functions for the transition to the ground state, with a total resolution of 2 keV, were determined for each reaction over this energy region. With the help of thick targets and both a single Ge(Li) detector and a Ge(Li) detector incorporated into a pair spectrometer, total summed spectra for the 700-keV region were obtained. The average total cross sections for the $^{88}Sr(p,\gamma_0)^{89}Y$ and $^{89}Y(p,\gamma_0)^{90}Zr$ reactions were 12 ± 5 μb and 17 ± 7 μb, respectively. These total summed spectra, which represent the total gamma-ray yield in this region, were examined for a possible dependence of the intensity on the J^π of the final state. The data suggest such a J-dependence hypothesis, but detailed theoretical analysis of the $^{88}Sr(p,\gamma)^{89}Y$ reaction does not completely agree with experiment. A spectrum from a Ge(Li) detector in coincidence with a NaI(Tl) detector was accumulated for the $^{88}Sr(p,\gamma)^{89}Y$ reaction. The decay scheme of the states of ^{89}Y up to an excitation energy of 3.621 MeV was determined, and the implications about spins and parities are consistent with accepted assignments. (auth)

53662 (COO-1468-9) PROGRESS REPORT [ON NUCLEAR PHYSICS], JANUARY 1970-DECEMBER 1970. Donahue, D. J.; McCullen, J. D.; McIntyre, L. C. Jr. (Arizona Univ., Tucson). 1971. 12p. Dep. NTIS.

Research in nuclear physics at the University of Arizona during 1970 is reported. Some of the completed but previously unreported work includes lifetime measurements for levels in ^{57}Ce, ^{29}P, ^{33}S, and ^{35}S. (J.W.R.)

53663 (COO-1505-48) DEEXCITATION PROCESSES IN NUCLEAR REACTIONS. Progress Report, May 1970-April 1971. Porile, Norbert T. (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). May 1971. Contract AT(11-1)-1505. 26p. Dep. NTIS.

COBALT-59—proton inelastic scattering at 14 MeV, proton spectra from, (E)
—proton reactions (p,α) at 14 MeV, α spectra from, (E)
COPPER—proton reactions at 450 MeV, γ spectra from, (E)
NICKEL-62—proton reactions (p,α) and (p,d) at 14 MeV, α and deuteron evaporation spectra from, (E)
—proton inelastic scattering at 14 MeV, angular distributions for, (E)
—proton reactions (p,α) at 14 MeV, angular distributions for, (E)
URANIUM-238—proton fission at 11.5 GeV, production cross sections and recoil ranges of A = 131 isobars from, (E) (J.W.R.)

53664 (INP-751) FORMATION OF ^{8}Be: A POSSIBLE EXPLANATION OF SOME BROAD RESONANCES IN THE ELASTIC SCATTERING OF α PARTICLES. Budzanowski, A.; Grotowski, K.; Strzalkowski, A. (Institute of Nuclear Physics, Krakow (Poland). Jagellonian Univ., Krakow (Poland). Inst. of Physics). Mar 1971. 8p. Dep. NTIS (U. S. Sales Only).

A model is proposed explaining the broad resonances in elastic scattering of α particles by some light nuclei with the formation of ^{8}Be cluster. (auth)

53665 BREAKDOWN OF THE EXTREME STATISTICAL MODEL IN NEUTRON CAPTURE. Mughabghab, S. F. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett.; 35B: No. 6, 469-71(5 Jul 1971).

Gamma-ray intensities due to thermal-neutron capture in ^{58}Ni can be predicted in terms of the valency-neutron model, in which an s-wave neutron is scattered "directly" into a low-lying $p_{1/2}$ or $p_{3/2}$ orbit in ^{59}Ni. Radiative width of the bound level at −28.5 ± 5 keV is determined to be 8.19 eV. (auth)

53666 ANGULAR MOMENTUM PROJECTION FROM NON AXIAL INTRINSIC STATES IN ^{28}Si. Watt, A. (Univ of Glasgow). Phys. Lett.; 35B: No. 6, 490-2(5 Jul 1971).

States of definite angular momentum projected from seven Hartree-Fock solutions of ^{28}Si are used as a basis in which to diagonalize the Hamiltonian. It is found that each of these HF solutions contributes appreciably to the low-energy spectrum. (auth)

53667 SYSTEMATICS OF NUCLEAR SINGLE PARTICLE STATES. Millener, D. J.; Hodgson, P. E. (Nuclear Physics Lab., Oxford). Phys. Lett.; 35B: No. 6, 495-7(5 Jul 1971).

The energies of 2s single-particle states are found to vary in a regular and systematic way from nucleus to nucleus in the range $35 \leq A \leq 65$. (auth)

53668 g-FACTOR OF THE ISOMERIC 9/2$^+$ STATE OF ^{81}Br. Christiansen, J.; Ingwersen, H.; Johann, H. G.; (and others) (Univ., Erlangen, Ger.). Phys. Lett.; 35B: No. 6, 501-2(5 Jul 1971).

The g factor of the isomeric $\frac{9}{2}^+$ state of ^{81}Br at 541 keV ($T_{1/2}$ = 32 μs) was measured by the stroboscopic method. The experimental value g = 1.261 ± 0.010 is compared with shell-model calculations. (auth)

53669 NEAR-VANISHING $0^+ \rightarrow 0^+$E0 MATRIX ELEMENT IN ^{58}Ni. Warburton, E. K.; Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett.; 36B: No. 1, 38-40(9 Aug 1971).

The branching ratio of the 0^+ state of ^{58}Ni at 2.94 MeV for decay by e^+-e^- pair emission to the 0^+ ground state is measured to be $(2.2 \pm 0.5) \times 10^{-4}$. This corresponds to a matrix element of 3.5×10^{-5} single-particle units, which is three orders of magnitude smaller than any previously measured E0 matrix element. The near-vanishing of this matrix element is discussed. (auth)

53670 TENSOR SPIN-SPIN POTENTIAL IN THE ^{59}Co + n REACTION. Fisher, T. R. (Lockheed Palo Alto Research Lab., Calif.). Phys. Lett.; 35B: No. 7, 573-5(19 Jul 1971).

The strength of the tensor spin-spin potential in the reaction ^{59}Co + n is estimated from recent measurements of the spin-spin effect in the total cross section. (auth)

53671 DEFORMATIONS IN ^{20}Ne, ^{24}Mg, AND ^{28}Si FROM ELECTRON SCATTERING. Horikawa, Y. (Tokyo Univ.); Torizuka, Y.; Nakada, A.; (and others). Phys. Lett.; 36B: No. 1, 9-11(9 Aug 1971).

The data of elastic and inelastic electron scattering from 0^+, 2^+, 4^+ states in ^{20}Ne, ^{24}Mg, and ^{28}Si were analyzed within the framework of the rotational model. The fits to the data are achieved by extending the Nilsson orbits to include higher oscillator states and introducing an additional Y_4 deformation into the Nilsson field. (auth)

53672 ^{47}Ca FIRST EXCITED-STATE ANALOGUE. Vingiani, G. B. (Univ., Padua. INFN, Padua); Chilosi, G.; Rossi-Alvarez, C. Phys. Lett.; 34B: 597-8(12 Apr 1971).

The ^{46}Ca(p,p) ^{46}Ca reaction was investigated at seven angles in the E_p = 1845 – 1880 keV region, corresponding to the position of the analog of the ^{47}Ca first excited state. The analog is split into several components. Gamma rays from ^{46}Ca(p,γ) ^{47}Sc were detected with a Ge(Li) counter. Partial widths are deduced. The analog-to-antianalog M1 transitions are strongly inhibited. (auth)

53673 QUADRUPOLE QUINTET IN ^{57}Co. Covello, A. (Univ., Naples. Istituto Nazionale di Fisica Nucleare, Naples); Manfredi, V. R. Phys. Lett.; 34B: 584-6(12 Apr 1971).

A quintet of states with $I^\pi = \frac{3}{2}^-, \frac{5}{2}^-, \frac{7}{2}^-, \frac{9}{2}^-, \frac{11}{2}^-$ in ^{57}Co is studied by coupling the $f_{7/2}$, $s_{1/2}$ and $d_{3/2}$ proton-hole states with quadrupole and octupole core vibrations. The single-hole energies and the deformation parameters β_λ are taken from experiments on ^{58}Ni. Most of the observed features of the quintet are successfully reproduced. (auth)

53674 ANGULAR DEPENDENCE OF HALF LIFE MEASUREMENTS IN ^{75}As AND ^{197m}Hg. Baeverstam, U.; Hoejeberg, M. (Univ. of Stockholm). Nucl. Instrum. Methods; 95: No. 3, 611-13(1971).

It is shown that delayed coincidence measurements of the life times of nuclear levels can be influenced by perturbations of the angular correlation of the measured cascade. The true half life of the 280 keV level in ^{75}As is determined to $T_{1/2}$ = 0.289 ± 0.010 ns. (auth)

53675 BRANCHING IN THE β^+ DECAY OF THE ^{42}Sc GROUND STATE. Garvey, G. T. (Brookhaven National Lab., Upton, N. Y. Princeton Univ., N. J.); Jones, K. W.; Schwalm, D.; Warburton, E. K. Phys. Lett.; 35B: No. 7, 563-6(19 Jul 1971).

The β^+ branch of the decay of the ^{42}Sc 0^+ ground state to the 1.83-MeV 0^+ state in ^{42}Ca is estimated to have an intensity of 0.06%. A preliminary measurement is reported showing $\Gamma_{0_2^+}/\Gamma_{0_1^+} < 1.2 \times 10^{-3}$. (auth)

53676 $J^\pi = 5^-$ LEVEL IN ^{34}S AT 5.689 MeV. Greene, M. Wayne; Keuhner, J. A.; Pilt, A. A. McMaster Univ., Hamilton, Ont.). Phys. Lett.; 35B: No. 7, 560-2(19 Jul 1971).

A polarization--direction correlation measurement at two angles, θ_γ = 60° and 90°, resulted in an unambiguous spin assignment of $J^\pi = 5^-$ for the 5.69-MeV level of ^{34}S. (auth)

53677 MASS OF ^{25}Si AND THE ISOBARIC MULTIPLET MASS EQUATION. Trentelman, G. F.; Proctor, I. D. (Michigan State Univ., East Lansing). Phys. Lett.; 35B: No. 7, 570-2(19 Jul 1971).

The mass excess of ^{25}Si was measured as 3,832 ± 12 keV via determination of the Q value for the ^{28}Si(^{3}He, ^{6}He)^{25}Si reaction. The results are used to test the isobaric-multiplet mass equation for A = 25. (auth)

53678 ^{28}Si AND ^{32}S IN A CONTINUUM SHELL-MODEL CALCULATION. Barrett, R. F. (Univ., Frankfurt am Main); Rabie, A.; Delsanto, P. P.; Piazza, A. Phys. Lett.; 35B: No. 7, 551-3 (19 Jul 1971).

The total photo-absorption cross sections of ^{28}Si and ^{32}S are calculated in a 1p–1h continuum-shell-model approximation by using the eigenchannel reaction theory. (auth)

53679 COULOMB ENERGIES AND THE ANOMALY IN NUCLEAR MATTER RADII. Friedman, E. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Lett.; 35B: No. 7, 543-5 (19 Jul 1971).

The extra symmetry potential due to isospin impurity is included in single-particle calculations of Coulomb displacemen energies. When a surface enhancement is included, the radii of the potential wells for the neutrons are found to be only very slightly smaller than the corresponding values for the protons. (auth)

53680 DISTORTION EFFECTS ON THE RECOIL MOMENTUM DISTRIBUTIONS IN (p,2p) REACTIONS. Gustafsson, C.; Berggren, T. (Lund Inst. of Tech., Sweden). Phys. Lett.; 35B: No. 7, 546-8(19 Jul 1971).

A DWIA analysis of recent measurements of the recoil momentum distributions in ^{28}Si(p,2p)^{27}Al shows that the observed variation can be explained within the framework of the optical model. (auth)

53681 STUDY OF DENSITY AND MOMENTUM DEPENDENT DELTA FUNCTION FORCES. Lassey, K. R. (McMaster Univ., Hamilton, Ont.); Volkov, A. B. Phys. Lett.; 36B: No. 1, 4-8 (9 Aug 1971).

The suitability of density- and momentum-dependent delta-function forces in nuclear calculations is studied using Hartree–Fock calculations in the 2s–1d shell. The effect of the compressibility upon deformation and rms radius is investigated. (auth)

53682 ISOSPIN NON-CONSERVING NUCLEON DECAYS OF T = $\frac{3}{2}$ LEVELS IN A = 21 NUCLEI. Cameron, J. M.; Neilson, G. C.; Sharma, T. C. (Univ. of Alberta, Edmonton). Phys. Lett.; 36B: No. 1, 35-7(9 Aug 1971).

The nucleon-decay branching ratios for the second T = $\frac{3}{2}$ states of the mass 21 system were measured. The ratios of the reduced widths to the ground state and 1.63-MeV state of ^{20}Ne show a marked asymmetry. (auth)

53683 K-MESON ABSORPTION ON NUCLEAR SURFACE. Komarov, V. A.; Krasnov, L. V.; Litvin, V. F. (Leningrad State Univ.). Yadern. Fiz.; 13: No. 6, 1189-91(Jun 1971). (In Russian).

By means of numerical solution of the Schroedinger equation with the Woods–Saxon potential with account of the spin–orbit interaction the proton and neutron density distributions in nuclei ^{16}O, ^{107}Ag, ^{58}Ni, ^{64}Ni are obtained that are used to estimate the proton–neutron ratio of the K^--meson absorption. It is shown that 75% of the effect of increase of the neutron-proton density ratio in the surface region for the heavy nuclei, as compared with the light nuclei, may be explained in framework of the simple shell model. This ratio for ^{64}Ni and ^{58}Ni is obtained to be ~2. (auth)

53684 STRUCTURE OF THE CROSS SECTION OF THE REACTION ^{40}Ca(γ,n) IN THE REGION OF THE GIANT RESONANCE. Ishkhanov, B. S.; Piskarev, I. M.; Kapitonov, I. M.; (and others) (Moscow State Univ.). Yadern. Fiz.; 13: No. 6, 1141-8(Jun 1971). (In Russian).

Yield curve is measured for the photoneutron reaction on ^{40}Ca nucleus in the region of the giant dipole resonance. The obtained cross section of the (γ,n) reaction has a number of maxima with widths of 300–600 keV. The experimental data are compared with the results of theoretical calculations. (auth)

53685 ELASTIC SCATTERING OF ELECTRONS FROM ^{40}Ar. Groh, J. L.; Singhal, R. P.; Caplan, H. S. (Saskatchewan Accelerator Lab., Saskatoon). Can. J. Phys.; 49: No. 15, 2073-5(1 Aug 1971).

The r.m.s. charge radius of argon-40 was measured by elastic electron scattering in the momentum transfer range $0.5 < q < 0.85$

fm^{-1}. The result obtained using a phase shift code and assuming a Fermi distribution was 3.473 ± 0.045 fm. (auth) (Canada)

53686 SPIN AND PARITY ASSIGNMENTS IN ^{77}As. Long, D. D.; Onega, R. J.; Sauer, R. C. (Virginia Polytechnic Inst., Blacksburg). Can. J. Phys.; 49: 2082-5(1 Aug 1971).

A directional correlation of the 0.56−0.63 MeV gamma rays following the beta decay of ^{77}Ge was obtained. The spin of the 1.19 MeV level of ^{77}As was determined as $^7/_2$. Parity assignments were made on the basis of the mixing ratios of the observed correlation for the 0.63 and 1.19 MeV levels. (auth) (Canada)

53687 MECHANISM OF THE REACTIONS ^{24}Mg(d,p)^{25}Mg AND ^{26}Mg(d,p)^{27}Mg IN THE DEUTERON ENERGY RANGE 1.3 TO 2.5 MeV. Omar, H. M.; Gontchar, V. Y.; Bakr, M. H. S.; Ali, M. A. (Atomic Energy Establishment, Cairo). Ann. Phys. (Leipzig); 26: No. 1, 8-22(1971).

The differential excitation functions of the low-lying levels for the reactions ^{24}Mg(d,p)^{25}Mg and ^{26}Mg(d,p)^{27}Mg have been measured in steps of 10 keV in a deuteron energy range 1.3 to 2.5 MeV and at angles 20° to 160° in steps of 20°. Thin isotopic targets (0.45 μ gm/cm^2) on Ni backing (0.5 micron) were used. Auto-correlations, angular and group cross-correlations, and probability distributions were calculated in terms of ERICSON's theory of statistical fluctuations. The mean coherence width Γ for both reactions was found to be equal to 32 keV which corresponds to a life time $\tau = 2.1 \times 10^{-20}$ sec of the compound nucleus formation. (auth)

53688 ENERGY AND ANGULAR CHARACTERISTICS OF ^{8}Li FRAGMENTS FROM FISSION OF ALUMINUM BY 660-MeV PROTONS. Azimov, S. A.; Aripov, R.; Beter, E. V.; Lozhkin, O. V. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 9, 22-4(1970). (In Russian).

The fragmentation of aluminum nuclei by 660-MeV protons results in ^{8}Li fragments. By drawing an analogy with reaction diagrams involving ^{9}Be and ^{12}C target nuclei, and disregarding spin effects, the energy spectra for ^{8}Li fragments was calculated and plotted for angles from 0° to 90°, and the angular distribution of such fragments was derived for small and large velocities. (K.S.W.)

53689 ELASTIC SCATTERING OF ALPHA PARTICLES BY ^{20}Ne AND ^{24}Mg. Takeda, Minoru; Kato, Syohei; Yamazaki, Takashi (Osaka Univ.). J. Phys. Soc. Jap.; 31: No. 3, 625-31 (Sep 1971).

Differential cross sections for the elastic scattering of alpha particles by ^{20}Ne and ^{24}Mg have been measured at laboratory angle of 176° as a function of incident energy in the range 20 to 24.5 MeV. In alpha−^{20}Ne scattering seven resonances have been observed. Angular distributions have been obtained at nine energies. Tentative spin and parity assignments have been made for five resonances, corresponding to the compound ^{24}Mg nucleus, by phase shift analysis. In the case of alpha−^{24}Mg scattering, many peaks appeared in the excitation curve which shows rather complicated features. Angular distributions have been measured at nine energies. (auth)

53690 LIFETIME MEASUREMENTS FOR ^{23}Na STATES BELOW $E_x = 4$ MeV. Bister, M.; Anttila, A.; Piiparinen, M. (Helsinki Univ.). Ann. Acad. Sci. Fenn., Ser. A VI; No. 349, 1-8 (1970).

The mean lives of seven ^{23}Na states below $E_x = 4$ MeV were measured with the Doppler-shift attenuation method in the ^{22}Ne(p, γ)^{23}Na reaction. Targets were prepared by implanting Ne ions into tantalum, molybdenum, and titanium. Excitation energies and branchings of the states in ^{23}Na are also presented. (auth) (Finland)

53691 SPIN AND PARITY OF THE 4458 keV STATE IN ^{32}S. Viitasalo, M.; Forsblom, I. (Helsinki Univ.). Commentat. Phys.-Math.; 40: 149-54(1970).

The resonance state spin and parity in the $E_p = 1949$ keV resonance in the ^{31}P(p,γ)^{32}S reaction were determined as 3^+. By measuring the angular distribution on the strong (66%) transition from the resonance state to the 4458-keV state, the spin and parity of this state was determined as 4^+. The 5410-keV level is proposed as a 3^+ level. A precise determination gave the energy values of the first and fourth excited states in ^{32}S as 2229.8 ± 0.3 keV and 4458.1 ± 0.7 keV. (auth) (Finland)

53692 ^{22}Ne(p,γ)^{23}Na REACTION AT PROTON ENERGIES FROM 1300 TO 2600 keV. Weckstroem, K.; Oesterlund, K. (Helsinki Univ.). Commentat. Phys.-Math.; 40: 141-7(1970).

In an investigation of the ^{22}Ne(p,γ)^{23}Na reaction, 34 unreported (p,γ) resonances were found in the energy region $E_p = 1300$ to 2600 keV. The gamma decay of ten selected resonances was determined at $E_p = 1588$, 1618, 1625, 1718, 1726, 1760, 1834, 1859, 1905 and 1997 keV, respectively. (auth) (Finland)

53693 NEUTRON INELASTIC SCATTERING CROSS SECTIONS FOR IRON, NICKEL, NIOBIUM, AND TANTALUM FROM THRESHOLD TO 1.8 MeV. Rogers, V. C.; Beghian, L. E.; Clikeman, F. M. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng.; 45: No. 3, 297-307(Sep 1971).

Gamma-ray production cross sections were measured for (n,n′γ) reactions in ^{56}Fe, ^{58,60,62}Ni, and ^{181}Ta for neutron energies from threshold to 1.8 MeV. Neutron inelastic scattering level excitation functions were then obtained from the gamma-ray production cross sections by correcting for internal conversion and for cascading transitions. A 17-cm^3 Ge(Li) spectrometer system was used to measure the gamma-ray spectra. The experimental results were compared with statistical model calculations using optical model transmission coefficients. Corrections for resonance interference and width fluctuations were also included in the computations. In general, the calculated results agreed with experiment to within the quoted error. Furthermore, the results for the deformed nucleus ^{181}Ta indicated that a spherical optical model potential may be used successfully to obtain the level excitation functions for this nucleus. (auth)

53694 INELASTIC INTERACTION CROSS SECTION OF NUCLEAR-ACTIVE PARTICLES WITH NUCLEI OF ALUMINUM AND LEAD ATOMS. Vardumyan, D. T.; Marikyan, G. A.; Matevosyan, K. A. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 5: 342-6(1970). (In Russian).

An experimental arrangement is described consisting of an ionization calorimeter and wide-gap spark chambers of 106 × 60 cm^2 operating area with aluminum and lead targets placed between them. Combined operation of the calorimeter and spark chambers allows one to investigate inelastic nuclear interactions, detecting primary and secondary particles in the chambers and measuring the primary particle energy in the calorimeter. Preliminary results are presented which are in good agreement with the data of other authors. (auth)

53695 ENERGY AND ANGULAR CHARACTERISTICS OF ^{8}Li FRAGMENTS FROM THE SPALLATION OF ALUMINUM NUCLEI BY 660 MeV PROTONS. Azimov, S. A.; Aripov, R.; Beter, E. V.; Lozhkin, O. V. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 5, 66-9(1970). (In Russian).

The release of ^{8}Li fragments from aluminum nuclei by 660 MeV protons was studied with a vacuum chamber and photoemulsion as a detector. In a single irradiation of the thin (2.4 mg/cm^2) aluminum foil, approximately 10^{13} protons/cm^2 yielded about 100 ^{8}Li traces. Differential energy spectra of the ^{8}Li fragments were obtained at various angles. The angular distribution was determined for slow and fast fragments of ^{8}Li. (K.S.W.)

53696 EMISSION OF CHARGED PARTICLES AFTER THE CAPTURE OF SLOW NEUTRONS IN ^{22}Na. Ehehalt, R.; Morinaga, H.; Shida, Y. (Technical Univ., Munich). Z. Naturforsch.; 26a: 590-1(Mar 1971). (In German).

The energy spectrum of charged particles was studied for ^{22}Na exposed to a slow-neutron beam of 3×10^6 n/sec · cm^2. The charged particles were analyzed with a Si detector. Protons of 2.25 MeV formed a strong line in the spectrum that resulted from the decay of the compound nucleus ^{23}Na to the first excited state of ^{22}Ne. Neither the protons belonging to the ground level of ^{22}Ne nor the α particles originating from the reaction ^{22}Na(n,α)^{19}F could be detected. Two energy lines at 1.43 and 1.77 MeV were identified as α particles from the undesired reaction ^{10}B(n,α)^{7}Li. (H.B.G.)

53697 COMPLETE EXPERIMENT IN BETA DECAY (A SURVEY OF CONTEMPORARY EXPERIMENTAL DATA). Gaponov, Yu. V. Usp. Fiz. Nauk; 102: 211-38(Oct 1970). (In Russian).

According to current theories of the universal weak interaction, beta decay of the neutron and complex nuclei is described as a weak process of the lepton−hadron type with conservation of strangeness, and knowledge of its Hamiltonian permits conclusions concerning the fundamental properties of the weak interaction as a whole. Theoretically, the effective Hamiltonian of beta interactions is obtained from the general relativistically-invariant form by assumptions concerning the practicability of three additional hypotheses—concerning the realization in weak interactions of V-A invariances, the helicity of neutrinos, and CP invariance. The form of such a Hamiltonian is determined from the sum total of experiments for determination of the spectrum and the angular and polarization correlations of the decay products; combining the results of all these experiments permits evaluation of all of the constants of the general relativistically-invariant Hamiltonian. The collection of such experiments forms a complete experiment. The main types of experiments constituting a complete experiment in the case of beta decay are examined and analyzed in detail. Numerical estimates of different parameters of general Hamiltonian are obtained. The degree of practicability of each of the enumerated hypotheses in beta decay is evaluated. (77 references) (tr-auth)

53698 QUARTET STRUCTURE AND COLLECTIVE EFFECTS IN THE SCANDIUM ISOTOPES. Spicer, B. M. (Catholic Univ. of America, Washington, D. C. National Bureau of Standards, Washington, D. C.); Danos, M. Z. Phys.; 246: No. 2, 97-103 (1971).

The systematics of the excitation energies of the nonnormal parity states of the scandium isotopes is interpreted in terms of the formation of a quartet of $1f_{7/2}$ nucleons. Calculation of the B(E2) value for a typical radiative transition between nonnormal parity states in ^{43}Sc, using this model, shows that the transition must involve more than the single quartet formed in the $1f_{7/2}$ shell; that is, core polarization is an important factor in determining the B(E2) value. (auth)

53699 EXCITATION FUNCTIONS OF REACTIONS INDUCED BY ALPHA PARTICLES WITH MAXIMUM ENERGY OF 38 MeV ON COPPER ISOTOPES. Zhukova, O. A.; Kanashevich, V. I.; Laptev, S. V.; Chursin, G. P. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 4, 1-8(Jul-Aug 1970). (In Russian).

By using the method of induced activity of stacked foils, excitation functions for the reactions ^{63}Cu(α,n)^{66}Ga, ^{63}Cu(α,2n)^{65}Ga + ^{63}Cu(α,pn)^{65}Zn, ^{65}Cu(α,2n)^{67}Ga, and ^{65}Cu(α,3n)^{66}Ga were measured from threshold to the maximum α-particle energy of 38.0 ± 0.3 MeV. The results of the measurements are compared with those of other authors. (tr-auth)

53700 DECAY OF ^{28}Si. Ahmed, N. (Atomic Energy Centre, Dacca, Pakistan); Rahman, M. A.; Awal, M. A.; (and others). Nucl. Sci. Appl., Ser. B; 5: 11-17(Oct 1969).

The ^{27}Al(p,γ)^{28}Si reaction in the energy range of E_p = 0.850 to 3.00 MeV was investigated. Gamma-ray spectra for five resonances at E_p = 0.922, 1.326, 1.799, 2.044, and 2.197 MeV were measured and analyzed by the "peeling off" method. Attempts are made to propose decay schemes at these resonance energies. (auth)

53701 PROTON SPIN FLIP IN INELASTIC SCATTERING. Ahmed, M. (Atomic Energy Centre, Dacca, Pakistan). Nucl. Sci. Appl., Ser. B; 5: 18-22(Oct 1969).

Proton spin-flip probabilities for the reactions ^{54}Fe(p,p') (Q = −1.41 MeV) and ^{60}Ni(p,p') (Q = −1.33 MeV) were measured at an incident energy of 10 MeV. The results are compared with the predictions of vibrational-collective-model coupled-channels calculations and Hauser–Feshbach statistical-model calculations. (auth)

53702 FLUCTUATIONS IN TOTAL CROSS SECTION OF Fe FOR 1- TO 2-MeV NEUTRONS. Hussain, M. (Univ. of Dacca, Pakistan); Islam, E.; Ameen, N.; Musa, Md. Nucl. Sci. Appl., Ser. B; 5: 23-7(Oct 1969).

Total neutron cross sections for Fe were measured between 1 and 2 MeV neutron energy at intervals of ~25 keV with statistical uncertainties ~2%. The data show fluctuations with energy in agreement with Agodi and Pappalardo's theory [Nucl. Phys., 47: 129(1963)] based on fluctuations in widths and spacings of compound-nucleus levels. The autocorrelation technique is used to estimate the ratio of average level width to level spacing, $\langle\Gamma\rangle/D$, from the observed fluctuations. The value seems to be higher than expected. Structures with widths intermediate between those of compound-nucleus resonances and single-particle resonances also seem to appear. (auth)

53703 RESONANCE STRENGTHS, BRANCHING RATIOS, AND MEAN LIFETIMES OF NUCLEAR ENERGY LEVELS IN ^{23}Na. du Toit, Z. B.; de Kock, P. R.; Mouton, W. L. (Univ. of Stellenbosch, S. Afr.). Z. Phys.; 246: No. 2, 170-82(1971).

The gamma decay of the ^{22}Ne(p,γ)^{23}Na resonances in the proton energy range E_p = 1.0 → 2.0 MeV was investigated with a 20-cm^3 Ge(Li) detector. Implanted targets were used. The absolute strengths of the strongest resonances were determined, and the branching ratios of twenty resonance levels and several bound states are reported. Mean lifetimes of the levels at E_x = 2.078 MeV (18.7 ± 3.5 fs), 2.393 MeV (580^{+370}_{-190} fs), 2.641 MeV (88^{+20}_{-11} fs), 2.985 MeV ($4.0^{+1.3}_{-1.0}$ fs), 3.679 MeV (24^{+7}_{-4} fs), 3.915 MeV ($7.4^{+3.5}_{-2.0}$ fs), and 4.775 MeV (<2.0 fs) were obtained from measurements of the gamma-ray Doppler shifts. (auth)

53704 SPIN DETERMINATION OF VARIOUS NUCLEAR LEVELS BY MEASUREMENT OF THE CIRCULAR POLARIZATION OF GAMMA RAYS AFTER CAPTURE OF POLARIZED THERMAL NEUTRONS. Knerr, R.; Vonach, H. (Technische Univ., Munich). Z. Phys.; 246: No. 2, 151-69(1971). (In German).

The circular polarization of the gamma radiation following capture of polarized slow neutrons in natural titanium, chromium, nickel, zinc, and selenium was investigated by means of a polarimeter using transmission of magnetized iron as polarization-sensitive effect. A large Ge diode was used for measurement of capture gamma spectra. By this way the spins of 55 levels in ^{49}Ti, ^{51}Cr, ^{53}Cr, ^{54}Cr, ^{59}Ni, ^{61}Ni, ^{63}Ni, ^{65}Zn, ^{67}Zn, ^{68}Zn, ^{77}Se, and ^{78}Se were determined. In 37 cases existing spin determinations were confirmed, in 1 case out results contradict earlier spin determinations, and 17 new spin assignments are made. (auth)

53705 EXPERIMENTS ON TRANSFER REACTIONS. Haeberli, W. (Univ. of Wisconsin, Madison). pp 235-66 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

Experimental research on transfer reactions performed in the period 1965 to 1970 is reviewed. The progress made in the measurement of polarization effects in transfer reactions is described in detail. The interplay that has occurred between experiment and theory as polarization data has become available is pointed out. Some areas where additional experiments are needed are discussed. (106 references) (J.W.R.)

53706 EXPERIMENTAL STUDIES OF THE POLARIZATION PRODUCED BY ELASTIC SCATTERING OF NEUTRONS IN THE VICINITY OF 1 MeV. Cox, S. A.; Dowling Whiting, E. E. (Argonne National Lab., Ill.). pp 631-2 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53707 ELASTIC SCATTERING OF POLARIZED 4-MeV NEUTRONS BY HEAVY AND MEDIUM-WEIGHT NUCLEI. Gorlov, G. V. (Inst. of Atomic Energy, Moscow). pp 633-7 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53708 DEPOLARIZATION IN ELASTIC SCATTERING OF 1.36-MeV POLARIZED NEUTRONS. Katori, K.; Nagata, T.; Mikoshiba, O.; Kobayashi, S. (Tokyo Univ. of Education). pp 638-40 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53709 EXPERIMENTAL OBSERVATION OF A DEFORMATION EFFECT IN THE NEUTRON TOTAL CROSS SECTION OF ^{59}Co USING A POLARIZED TARGET. Fisher, T. R. (Lockheed Palo Alto Research Lab., Calif.); Healey, D. C.; McCarthy, J. S.; Parks, D. pp 641-2 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53710 POLARIZATION EXPERIMENTS ON Si AND Si-POLARIMETERS. Bangert, R.; Gonsior, B.; Roesner, P.; (and others) (Univ., Cologne). pp 646-8 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53711 ENERGY DEPENDENCE OF CROSS SECTIONS AND POLARIZATIONS MEASURED IN PROTON ELASTIC SCATTERING FROM ^{48}Ca BETWEEN 6 AND 13 MeV. Liers, H. S. (Univ. of Wisconsin, Madison). pp 649-50 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53712 INVESTIGATION OF SPIN-ORBIT AND SPIN–SPIN INTERACTIONS IN THE OPTICAL MODEL BY VECTOR-POLARIZED DEUTERONS. Wilsch, H.; Heil, G.; Klier, G. (Univ., Erlangen, Ger.). pp 663-4 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53713 VECTOR ANALYZING POWER IN THE ELASTIC AND INELASTIC SCATTERING OF DEUTERONS FROM ^{24}Mg. Brown, R. C.; Griffith, J. A. R.; Hudson, G.; (and others) (Univ. of Birmingham, Eng.). pp 668-9 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53714 TENSOR POLARIZATION OF DEUTERONS FROM Mg(d,d)Mg ELASTIC SCATTERING AT 7.0 MeV. Djaloeis, A.; Nurzynski, J. (Australian National Univ., Canberra). pp 670-2 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53715 CROSS-SECTION AND VECTOR ANALYZING POWER MEASUREMENTS FOR 9-, 11-, AND 13-MeV DEUTERONS ELASTICALLY SCATTERED FROM ^{27}Al, Si, ^{46}Ti, ^{48}Ti, ^{53}Cr, ^{68}Zn, ^{90}Zr, AND ^{120}Sn. Lohr, J. M.; Haeberli, W. (Univ. of Wisconsin, Madison). pp 675-6 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53716 GENERAL SET OF ^{3}He AND TRITON OPTICAL-MODEL POTENTIALS FOR A > 40, E < 40 MeV. Becchetti, F. D. Jr.; Greenlees, G. W. (Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1265. pp 682-3 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53717 COLLECTIVE-MODEL ANALYSIS OF INELASTIC PROTON SCATTERING USING POTENTIALS DERIVED FROM NUCLEAR MATTER DISTRIBUTIONS. Hnizdo, V.; Greaves, P. D.; Karban, O.; Lowe, J. (Univ. of Birmingham, Eng.). pp 690-1 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53718 HEXADECAPOLE DEFORMATION AND ASYMMETRY IN INELASTIC SCATTERING OF 24.5-MeV POLARIZED PROTONS FROM ^{20}Ne AND ^{22}Ne. Bacher, A. D.; de Swiniarski, R.; Hendrie, D. L.; (and others) (Univ. of California, Berkeley). pp 708-11 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53719 ASYMMETRY IN THE INELASTIC SCATTERING OF 15.7-MeV POLARIZED PROTONS FROM ^{63}Cu AND ^{65}Cu. Dost, M.; Glashausser, C.; Haynes, C. F.; Preissner, H.; Schneider, H. (Rutgers–The State Univ., New Brunswick, N. J.). pp 714-15 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53720 POLARIZATION OF PROTONS INELASTICALLY SCATTERED ON ^{24}Mg, ^{52}Cr, AND ^{58}Ni. Ruh, A.; Marmier, P. (Eidgenoessische Technische Hochschule, Zurich). pp 716-17 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53721 DWBA CALCULATIONS FOR (d,p) REACTIONS INCLUDING THE D-STATE OF THE DEUTERON. Delic, G.; Robson, B. A. (Australian National Univ., Canberra). pp 763-4 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53722 VECTOR ANALYZING POWER OF THE REACTIONS ^{24}Mg(d,p)^{25}Mg AND ^{16}O(d,p)^{17}O. Hudson, G.; Brown, R. C.; Govil, I.; (and others) (Univ. of Birmingham, Eng.). pp 777-8 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53723 POLARIZATION EFFECTS IN THE l = O REACTION ^{28}Si(d,p)^{29}Si(g.s.). Seyler, R. G. (Ohio State Univ., Columbus); Goldfarb, L. J. B. pp 779-81 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53724 POLARIZATION TRANSFER IN THE REACTION ^{28}Si(d,p)^{29}Si. Brown, R. C.; Griffith, J. A. R.; Karban, O.; Roman, S. (Univ. of Birmingham, Eng.). pp 782-3 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53725 ENERGIES OF THE $2p_{3/2}$, $2p_{1/2}$, $1f_{5/2}$, AND $1f_{7/2}$ SINGLE-PARTICLE STATES IN ODD-A NUCLEI OBTAINED FROM MEASUREMENTS OF THE (d,p) VECTOR ANALYZING POWER AND CROSS SECTION. Kocher, D. C.; Haeberli, W. (Univ. of Wisconsin, Madison). pp 784-5 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

53726 MEASUREMENT OF THE (d,p) VECTOR ANALYZING POWER FOR $l_n = 4$ TRANSITIONS ON INTERMEDIATE WEIGHT NUCLEI. Kocher, D. C.; Rathmell, R. D.; Haeberli, W. (Univ. of Wisconsin, Madison). pp 786-7 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO−7-593; CONF-700811.

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Refer also to abstracts 51584, 52291, 52292, 52987, 53019, 53485, 53492, 53493, 53529, 53602, 53620, 53623, 53645, 53647, 53661, 53663, 53674, 53679, 53683, 53693, 53694, 53697, 53705–53708, 53715, 53717, 53726, 53838, 53863, 53871, 53877, and 53878.

53727 (A/CONF.49/P–447) SEARCH AND SYNTHESIS OF FAR TRANSURANIUM ELEMENTS. Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). Apr 1971. 14p. (In Russian). (CONF-710901–488). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Methods of producing and investigating new transuranium elements are analysed. The analysis of three research development stages of transuranium elements is briefly presented. The experimental results of the synthesis and investigations of 102-105 isotopes obtained in the Laboratory of nuclear reactions are discussed. It is shown that the physical and chemical investigations of these elements made it possible defining the bound of actinide element group and getting information about the properties of their radioactive decay. The progress in search and synthesis methods of far transuranium elements for a new stability region from $108 \le Z \le 128$ $N \sim 184$ is considered. The results of searching of spontaneous fission super heavy elements by means of dielectric detectors and large proportional counters are discussed. Possible trends of the progress in searching of far transuranium elements and identifying methods of these elements are considered. These methods are: measurement of the number of neutrons per spontaneous fission of superheavy elements; determination of mass number of the isotopes of these elements by means of an electromagnetic separator, etc. Some possibilities of synthesis and identification of far transuranium elements using accelerated heavy argon ions (Zn, Kr, Xe, etc.) are presented. It is shown that by using ions heavier than Xe, fission may be the most promising method of synthesis of superheavy elements. (auth)

53728 (AECD/EP-18) NEUTRON TOTAL CROSS SECTION DATA MEASURED WITH THE 3-MeV A.E.C.D. VAN-DE-GRAAFF ACCELERATOR. Ameen, Nurul; Husain, Mozammel (comps.) (Atomic Energy Centre, Dacca (Pakistan)). Dec 1970. 21p. Dep. NTIS (U. S. Sales Only).

A compilation of the neutron total cross-section data measured with the 3-MeV Van de Graaff accelerator at Atomic Energy Centre, Dacca, is presented. The measurements were made using the transmission method with the d-c beam from the machine. The neutrons were separated from the gamma rays by using n–γ discrimination methods. (R.W.R.)

53729 (AECL-3865) PHYSICS DIVISION PROGRESS REPORT, OCTOBER 1–DECEMBER 31, 1970. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 98p. (PR-P-88). Dep. NTIS (U. S. Sales Only). AECL $2.00.

Research progress at the Physics Division of AECL from Oct. 1 to Dec. 31, 1970 is reported. Brief sketches of the activities of the nuclear physics branch, the general physics branch, the neutron physics branch, the theoretical physics branch, and the mathematics and computation branch are provided. (J.W.R.)

53730 (AWRE-O-44/71) EVALUATION OF $\bar{\nu}$ FOR ^{238}U. Mather, D. S.; Bampton, P. F. (Atomic Weapons Research Establishment, Aldermaston (England)). Jul 1971. 17p. Dep. NTIS (U. S. Sales Only). UK 15p. (EANDC(UK)-136-AL).

An evaluation using data available up to December 1970 was made of direct measurements for $\bar{\nu}$ for the neutron-induced fission of ^{238}U. A set of three straight lines is found to give the best representation of the variation of $\bar{\nu}$ with neutron energy, and values specifying this evaluation were produced for entry in a new Data File DFN-272. (auth)

53731 (CONF-701002–, pp 221-45) PRECISE LOW-ENERGY FISSION CROSS SECTIONS. Deruytter, A. J. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

This paper deals with precise 2200 m/sec fission-cross-section measurements, especially for ^{235}U and ^{239}Pu. Direct and indirect (spectrum dependent) data and their main sources of errors are discussed: (1) the determination of the absolute amount of fissile atoms; (2) the absolute counting of the number of fission events; (3) the precise knowledge of a reference cross section and its use; and (4) the spectrum dependence of indirect measurements. Based on this discussion, average values for the 2200 m/sec values of 587.4 ± 2.7 b for ^{235}U and 742.1 ± 3.2 b for ^{239}Pu and a σ_f ratio for ^{239}Pu/^{235}U of 1.263 ± 0.008 are proposed. The normalization of ^{235}U and ^{239}Pu fission cross sections in the resonance region is also discussed, and a common normalization of ^{235}U data based on a fission integral from 7.8 to 11 eV of 240.0 ± 2.1 b · eV is suggested. (auth)

53732 (CONF-701002–, pp 246-56) FAST FISSION CROSS SECTIONS AND FLUCTUATIONS. Bowman, C. D. (California Univ., Livermore. Lawrence Radiation Lab.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The effect of fluctuations in the ^{235}U fission cross section on absolute fission-cross-section measurements in the thousand-electron-volt and million-electron-volt range is considered. It is shown that present techniques using primarily charged-particle-induced neutron sources and spot-normalization techniques probably are inadequate to provide the ≤2% accuracy requested for most fissile isotopes. A program of experiments involving, primarily, white-source techniques is proposed for obtaining the required accuracy. It circumvents most of the problems of absolute fission and flux monitoring and also properly handles the effects of intermediate structure. (auth)

53733 (CONF-701002–, pp 257-71) NEW ABSOLUTE MEASUREMENT OF THE NEUTRON-INDUCED FISSION CROSS SECTIONS OF ^{235}U, ^{239}Pu, AND ^{241}Pu FROM 17 keV TO 1 MeV. Szabo, I.; Filippi, G.; Huet, J. L.; Leroy, J. L.; Marquette, J. P. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The fast-neutron-induced fission cross sections of ^{235}U, ^{239}Pu, and ^{241}Pu have been measured from 17 keV to 1 MeV with monoenergetic neutrons from the Cadarache Van de Graaff. Neutron flux was measured with standard counters, which were calibrated by three independent absolute methods. Fluctuation in the response time of the fission chambers was reduced to less than 7 nsec with a special electronic arrangement. This fast response made it possible to use the time-of-flight method to separate fission events due to background neutrons. Monte Carlo calculations were used to obtain corrections for neutron scattering from the walls of the fission chamber and from the neutron source. The total error in the measured cross sections was of the order of 3%. Comparison is made with the results of other laboratories. In addition to the cross sections, a new value for the spontaneous fission half-life of ^{240}Pu was determined: $T_{½} = 1.18 \pm 0.024 \times 10^{11}$ years. (auth)

53734 (CONF-701002–, pp 281-4) MEASUREMENTS OF THE ^{235}U FISSION CROSS SECTION AT 552 AND 644 keV. Poenitz, W. P. (Argonne National Lab., Ill.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The fission cross section of ^{235}U has been measured at 552 and 644 keV using the associated activity method. The ^{51}Cr activity associated with the neutrons from the ^{51}V (p,n) source reaction has been used to determine the neutron flux. The fission events have been measured in a spherical ionization chamber that surrounds the neutron source. The results are 1.085 ± 0.043 b at 552 keV and 1.066 ± 0.042 b at 644 keV. (auth)

53735 (CONF-701002–, pp 285-312) NEUTRON-CAPTURE-CROSS-SECTION STANDARDS. Carlson, A. D. (Gulf Radiation Technology, San Diego, Calif.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

Techniques employed in measuring capture cross sections are reviewed to determine what conditions should be satisfied by capture-cross-section standards. The elements satisfying most of these conditions are Rh, Ag, In, I, Tb, Ho, Tm, Ta, Re, Ir, and Au. For each of these elements, the measurements of the capture cross section are examined to determine the status of the cross section as a working standard. (auth)

53736 (CONF-701002–, pp 313-19) ROLE OF SELF-SHIELDING AND MULTIPLE SCATTERING IN CAPTURE-STANDARDS WORK. Froehner, F. H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

A short review is given on the self-shielding and multiple-scattering corrections in capture-standards work. Three areas are treated in detail: (1) multiple-interaction corrections to thermal capture data, (2) yield calculations for "saturated resonance" normalization, and (3) correction of average capture cross-section and shell-transmission data for effects of unobserved resonances. (auth)

53737 (CONF-701002–, pp 320-6) ABSOLUTE CROSS SECTIONS OF ^{197}Au AND ^{238}U. Poenitz, W. P. (Argonne National Lab., Ill.).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The absolute cross-section measurements of ^{197}Au(n,γ) and ^{238}U(n,γ) are discussed. Very good agreement is found in the data taken in the last 10 years. The uncertainty of average cross sections has been estimated to be about 5% for ^{238}U(n,γ) and 3% for ^{197}Au(n,γ). (auth)

53738 (CONF-701002–, pp 465-9) MEASUREMENTS OF THE HALF-LIVES OF THE URANIUM ISOTOPES. De Bievre, P.; Lauer, K. F.; Le Duigou, Y.; Moret, H.; Mueschenborn, G.; Spaepen, J.; Spernol, A.; Vaninbroukx, R.; Verdingh, V. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

At the Central Bureau for Nuclear Measurements in Geel, a long-term program in the field of accurate determination of uranium half-lives is under way. At the moment only the measurements on ^{234}U are worth mentioning. A recapitulation of the many results obtained using different source materials and assay techniques is given. The results are briefly discussed, and possible systematic errors are mentioned. A "best" value of 2.445 × 10^5 years is calculated, to which for the moment a maximum error of ±0.7% is attributed. Further measurements to improve the accuracy together with an extension of the studies to ^{235}U and ^{233}U will be undertaken. (auth)

53739 (FEI–195) VARIATIONS OF CUMULATIVE YIELD OF FRAGMENTS OF PRECURSORS OF DELAYED NEUTRONS OF ^{232}Th. Maksyutenko, B. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1970. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The relative yields of delayed neutrons from the fissioning of thorium-232 were determined for neutron energies of 1.7, 1.9, 2.1, 2.3, and 3.0 MeV. The measurements were conducted on a van de Graaff machine, by using the T(p,n)^{3}He reaction on a target of 1.6 mg/cm^2 thickness. Ten groups were distinguished, of which seven were pure precursors of delayed neutrons. The charge distribution for fission was established from the yields of delayed neutrons from bromine isotopes. The original charge distribution had the same width at all energies, viz. 0.537 ± 0.016 units of charge. Between 1.7 and 2.5 MeV, an increase in the yield of bromine isotopes was observed; between 2.5 and 3.0 MeV, a decrease occurred on account of the contribution from the beta decay of selenium isotopes. This effect was associated with a displacement of the charge in fission. The maximum displacement for the transition from 1.9 MeV to 2.3 MeV amounted to 0.17 units of charge. The values of the largest probable charge was determined for mass numbers at the energies indicated. (tr-auth)

53740 (FRNC-TH–41) STUDY OF NEUTRON HOLE STATES IN THE N = 82 NUCLEI. Chaumeaux, Alain (Paris Univ., Orsay (France). Faculte des Sciences). [dn]. 43p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A systematic study was made of neutron hole states in the closed N = 82 shell by investigating (p,d) pick-up reactions at 24.55 MeV with ^{138}Ba, ^{140}Ce, ^{142}Nd, and ^{144}Sm resulting in the formation of the following N = 81 nuclei: ^{137}Ba, ^{139}Ce, ^{141}Nd, and ^{143}Sm, respectively. The angular distributions measured are compared to those predicted by distorted-wave calculations using the DWUCK program. The spectroscopic factors are deduced from this comparison. In order to obtain sufficiently precise values for the spectroscopic factors a high resolution device was used; this device is described. (France)

53741 (IAE–1976) MEASURING THE γ-RAY SPECTRA OF ^{150}Sm(n,γ)^{151}Sm AND ^{151}Sm(n,γ)^{152}Sm REACTIONS IN A SAMPLE IN WHICH ^{149}Sm IS BURNED OUT AND ^{151}Sm IS ACCUMULATED. Groshev, L. V.; Demidov, A. M.; Leonov, V. F.; Sokolovskii, L. L. (Institut Atomnoi Energii, Moscow (USSR). 1970. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The γ-ray spectra from radiative capture of thermal neutrons by ^{150}Sm nuclei and radioactive ^{151}Sm nuclei were measured by means of a monocrystalline Ge(Li) γ spectrometer. The required purity of the sample with respect to ^{149}Sm was achieved by burning out the ^{149}Sm in an integral neutron fluence of 2.2 × 10^{20} n/cm^2. The binding energies of the neutron in the ^{151}Sm (5,596 ± 1 kiloelectron volt) and in the ^{152}Sm (8,258 ± 1 kiloelectron volt) were determined. The energies and intensities were determined for the γ lines separated from the spectrum. Schematics were constructed for the γ transitions of ^{151}Sm and ^{152}Sm. (JPRS)

53742 (INR–1275) (n,α) REACTIONS ON DYSPROSIUM ISOTOPES INDUCED BY 14.2 MeV NEUTRONS. Jaskola, M.; Osakiewicz, W.; Turkiewicz, J.; Zemlo, L.; Madej, M.; Stodolska, A. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 17p. Dep. NTIS (U. S. Sales Only).

The energy distributions of alpha particles from (n,α) reactions with ^{160}Dy, ^{161}Dy, ^{163}Dy, and ^{164}Dy induced by 14.2-MeV neutrons at 0° were measured using a semiconductor-detector technique. They cannot be accounted for by the evaporation theory. The shapes of the experimental spectra suggest the presence of the direct effect with strong excitation of single-neutron levels in the final nucleus. (auth)

53743 (INR–1318) PROGRESS REPORT ON NUCLEAR DATA RESEARCH IN POLAND, MAY 1970–APRIL 1971. Marcinkowski, A. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 54p. Dep. NTIS (U. S. Sales Only).

ANTIMONY—neutron capture at 400 keV, cross sections for, (E)
ARSENIC-75—neutron reactions (n,2n) and (n,p) at 13.02 to 17.78 MeV, excitation functions for, (E)
CADMIUM-111—neutron inelastic scattering at 14.8 MeV, cross section for, (E)
CADMIUM-112—neutron reactions (n,2n) at 14.8 MeV, cross section for, (E)
CESIUM-133—neutron capture at 400 keV, cross sections and spectra from, (E)
DYSPROSIUM-160—neutron reactions (n,α) at 14.2 MeV, statistical analysis of energy spectra from, (E)
DYSPROSIUM-162—neutron reactions (n,α) at 14.2 MeV, statistical analysis of energy spectra from, (E)
DYSPROSIUM-164—neutron reactions (n,α) at 14.2 MeV, statistical analysis of energy spectra from, (E)
EUROPIUM-153—neutron reactions (n,α) at 14.2 MeV, statistical analysis of energy spectra from, (E)
GALLIUM-71—neutron reactions (n,2n) and (n,p) at 13.36 to 16.51 MeV, excitation functions for, (E)
GOLD-197—neutron capture at 400 keV, cross sections for, (E)
HOLMIUM-165—neutron capture at 400 keV, cross sections for, (E)
INDIUM-115—neutron capture at 400 keV, cross sections for, (E)
IODINE-127—neutron capture at 400 keV, cross sections for, (E)
LEAD-204—neutron reactions (n,2n) at 14.8 MeV, cross section for, (E)
OSMIUM-190—neutron inelastic scattering at 14.8 MeV, cross section for, (E)
—neutron reactions (n,p) and (n,n'γ) at 14.8 MeV, gamma spectra from, (E)
PALLADIUM-110—neutron reactions (n,2n) at 14.8 MeV, cross section for, (E)
PALLADIUM-108—neutron reactions (n,2n) at 14.8 MeV, cross section for, (E)
PROTACTINIUM-230—electron-capture decay of, Q value for, (E)
RADIATION TARGETS—preparation of deuterium and tritium, methods for
RHENIUM-190—isomeric transition in, half-life for, (E)
RUBIDIUM-85—neutron reactions (n,2n) at 14.8 MeV, cross section for, (E)
RUBIDIUM-87—neutron reactions (n,2n) at 14.8 MeV, cross section for, (E)
SELENIUM-80—neutron reactions (n,2n) and (n,np) at 13.02 to 17.78 MeV, excitation functions for, (E)
SELENIUM-82—neutron reactions (n,2n) at 13.02 to 17.78 MeV, excitation functions for, (E)
TANTALUM-181—neutron capture at 400 keV, cross sections for, (E)
TERBIUM-159—neutron capture at 400 keV, cross sections for, (E)
THALLIUM—neutron capture at 400 keV, cross sections and spectra from, (E)
THORIUM-230—energy levels from protactinium-230 electron-capture decay, spin–parity assignments for, (E)
TIN-117—neutron reactions (n,p) at 13.02 to 16.51 MeV, excitation function for, (E)
—neutron inelastic scattering at 13.36 to 15.36 MeV, excitation function for, (E)
TIN-118—neutron reactions (n,2n) at 13.02 to 15.88 MeV, excitation function for, (E)
TRITIUM—deuteron reactions (d,n) at 0.5 to 1.6 MeV, angular and energy-dependence of neutron polarization from, (E)
TUNGSTEN-186—neutron reactions (n,2n) at 14.8 MeV, cross section for, (E)
URANIUM-232—energy levels from protactinium-232 beta decay, spin-parity assignments for, (E)
—energy-level transitions from protactinium-232 beta decay, multipolarities for, (E)
URANIUM-235—neutron fission of, energy–angular distribution of alpha particles from thermal, (E)
URANIUM-238—neutron capture at 400 keV, cross sections

for, (E)
YTTRIUM-89—neutron inelastic scattering at 14.8 MeV, cross section for, (E) (R.W.R.)

53744 (JINR-P-7-5814) SEARCH FOR TRACKS OF THE SPONTANEOUS FISSION FRAGMENTS OF FAR TRANSURANIUM ELEMENTS IN NATURAL MINERALS. Otgonsuren, O.; Perelygin, V. P.; Tretiakova, S. P.; Vinogradov, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 14p. (In Russian). Dep. NTIS (U. S. Sales Only).

Using the dielectric track detector method a search was made for the tracks of spontaneous fission fragments of far transuranium elements in a great number of minerals containing an admixture of heavy elements. An excessive density of the fission fragment tracks was observed for two samples—mica and quartz containing the pyrite inclusions. The hypothesis on spontaneous fission of unknown transuranium nuclide can be one of the explanations of this effect. The problem is discussed about identification of the above-mentioned tracks in natural minerals and, in particular, in minerals from meteorites. (auth)

53745 (JINR-P4-5872) STUDY OF THE E1-INTRANUCLEAR CONVERSION ON THE BASIS OF THE SAXON-WOODS POTENTIAL. Feresin, A. P.; Shul'ts, G.; Fainer, U. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

The experimental values for the matrix elements of γ radiation and intranuclear conversion for a number of strongly hindered E1 transitions are compared with the theoretical calculations made on the basis of the Saxon-Woods potential with pair correlations and the Coriolis interaction taken into account. For the comparison of experimental and theoretical values of the penetration matrix elements, the g_s-factors are found for the E1 transitions investigated. (auth)

53746 (KFK-1393) SYSTEMATICS OF THE HALF LIVES OF THE ACTINIDES AND DECAY OF ^{235}Pu. Keller, K. A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Apr 1971. 42p. (In German). Dep. NTIS (U. S. Sales Only).

Semiempirical relationships were derived for the prediction of partial half-lives for α decay and electron capture. By use of mean excitation energies of the daughter nuclides an improved accuracy could be obtained. The decay of ^{235}Pu was investigated to extend the systematics of the mean excitation energies. (auth)

53747 (MIT-3944-2) GAMANL: A COMPUTER PROGRAM APPLYING FOURIER TRANSFORMS TO THE ANALYSIS OF GAMMA SPECTRAL DATA. Harper, T.; Inouye, T.; Rasmussen, N. C. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Aug 1968. Contract AT(30-1)-3944. 87p. (MITNE-97). Dep. NTIS.

GAMANL, a computer code for automatically identifying the peaks in a comple· spectrum and determining their centers and areas, is described. The principal feature of the method is a data-smoothing technique employing Fourier transforms. The smoothing eliminates most of the random fluctuations without affecting the spectral resolution, and makes identification of maxima using a zero-slope criterion possible. If the same Fourier transform is used with different constants, it is possible with a second transformation to improve the spectral resolution. The computer program is written in FORTRAN IV for the M.I.T. IBM 360, model 65 computer and also for the Toshiba Electric Company G.E. 635 computer. The complete analysis of a 4096-channel spectrum containing one hundred twenty peaks requires about 75 seconds of computation time. (auth)

53748 (NP-18872) NUCLEAR PHYSICS INSTITUTE ANNUAL REPORT 1970. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). 1970. 170p. (In French). Dep. NTIS.

A review is made of the principal activities of the Orsay nuclear physics institute in 1970. The following broad topics are covered: nuclear physics, high energy physics, radiochemistry, theoretical physics. A list is given of the seminars, publications, communications, and theses. (France)

53749 (NP-18927) NUCLEAR STRUCTURE OF THE 107 AND 115 ISOTOPES OF INDIUM AND CORRELATIONS IN THE GROUND STATE OF CADMIUM TARGET NUCLEI FROM Cd(^{3}He,d)In REACTIONS. Thuriere, Evelyne (Paris Univ. (France). Faculte des Sciences). 1970. 117p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The reactions ^{114}Cd(^{3}He,d)^{115}In, ^{106}Cd(^{3}He,d)^{107}In, and ^{115}In(d,d′) ^{115}In were studied. The experimental equipment is described. The principal characteristics of the DWBA method of analysis and the approximations it implies are recalled. The structure of the ^{115}In levels with positive parities is discussed, and a tentative explanation in the framework of spherical orbitals, deformed orbitals, and weak coupling is given. (France)

53750 (NYO-73-340) DIVISION OF NUCLEAR SCIENCE AND ENGINEERING PROGRESS REPORT, JANUARY 1-DECEMBER 31, 1970. (Columbia Univ., New York. School of Engineering and Applied Science). Contract AT(30-1)-73. 61p. Dep. NTIS.

RADIATION DETECTORS, SCINTILLATION—design and operation of Maxon-Rae, for neutron capture measurements below 100 keV
THORIUM-229—neutron fission up to 50 eV, cross section and resonance parameters for, (E)
THORIUM-232—neutron total cross section up to 10 keV, (E)
URANIUM-233—neutron fission at 15 to 30 eV, cross section for, (E)
URANIUM-235—neutron fission at 17 to 22 eV, cross section for, (E)
—neutron fission at 10 to 40 keV, cross section for, (E)
URANIUM-238—neutron total cross section and resonance parameters up to 10 keV, (E) (J.W.R.)

53751 (ORNL-4655) GRAPHICAL COMPARISON OF CALCULATED INTERNAL CONVERSION COEFFICIENTS: HAGER-SELTZER VS SLIV-BAND. Ewbank, W. B. (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 101p. Dep. NTIS.

The calculated Hager-Seltzer and Sliv-Band internal conversion coefficients are compared graphically and tabulated. For each multipolarity (E1 to E4, M1 to M4) and for each shell (K, L1, L2, L3) the percentage difference is calculated for every energy given by Sliv and Band and for atomic numbers Z = 35, 40, 45, ... 95. The comparison is made for the coefficients themselves and for shell ratios. Over two-thirds of the compared values agree within less than 10%. (R.W.R.)

53752 (ORNL-4659) PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1970. Obenshain, Felix E. (ed.) (Oak Ridge National Lab., Tenn.). May 1971. Contract W-7405-eng-26. 137p. Dep. NTIS.

BROMINE-81—energy levels from oxygen-16 Coulomb excitation, lifetimes of, (E)
CADMIUM-116—oxygen-16 reactions at 140 MeV charged-particle energy spectra from, (E)
CALCIUM-40—proton inelastic scattering at 30 MeV, analysis using realistic interaction, (T)
CARBON-13—alpha reactions (α,n) at 1 to 5 MeV, cross section for, (E)
ELECTRON MICROSCOPY—use for DNA sequence determination, feasibility of
FLUORINE IONS—electron spectra and lifetimes from fast beams of
HELIUM-4—binding energy of, calculation using renormalized Brueckner-Hartree-Fock method with center-of-mass corrections, (T)
INDIUM-111—energy levels from cadmium-111 (p,n) reactions, lifetimes of, (E)
INDIUM-113—energy levels from cadmium-113 (p,n) reactions, lifetimes of, (E)
MESONS (π^+)—interactions $\pi^+ + N \rightarrow \rho + \Delta$ at 8 GeV/c in deuterium bubble chamber, (E)
MOLYBDENUM-98—oxygen-16 reactions (O-16,xn) at 80 MeV, γ spectra from, (E)
NEON-21—alpha reactions (α,n) at 1 to 5 MeV, cross section for, (E)
NEON-22—alpha reactions (α,n) at 1 to 5 MeV, cross section for, (E)
NUCLEIC ACID, DEOXYRIBO—sequence determination using electron microscopy, feasibility of
NUCLEONS—interactions $\pi^+ + N \rightarrow \rho + \Delta$ at 8 GeV/c in deuterium bubble chamber, (E)
OXYGEN IONS—electron spectra and lifetimes from fast beams of
OXYGEN-16—reactions with cadmium-116 at 140 MeV, charged-particle energy spectra from, (E)
—binding energy of, calculation using renormalized Brueckner-Hartree-Fock method with center-of-mass corrections, (T)
—neutron total cross section at 1.7 to 4.4 MeV, (E)
OXYGEN-17—alpha reactions (α,n) at 1 to 5 MeV, cross section for, (E)
SELENIUM-72—energy-level scheme from bromine-72

decay, (E)
SELENIUM-74—energy level scheme from bromine-74 decay, (E)
STRONTIUM-86—proton elastic and inelastic scattering at 12 MeV, differential cross sections for, (E)
TIN-117—proton reactions (p,n) at 3 to 7 MeV, strength function for, (E)
TIN-118—proton reactions (p,n) at 3 to 7 MeV, strength function for, (E)
TIN-119—proton reactions (p,n) at 3 to 7 MeV, strength function for, (E)
TIN-120—proton reactions (p,n) at 3 to 7 MeV, strength function for, (E)
TIN-122—proton reactions (p,n) at 3 to 7 MeV, strength function for, (E)
TIN-124—proton reactions (p,n) at 3 to 7 MeV, strength function for, (E)
URANIUM-236—neutron fission at 0.5 to 8 MeV, cross section for, (E)
YTTRIUM-89—proton inelastic scattering at 61 MeV, analysis using realistic interaction, (T)
ZIRCONIUM-90—proton inelastic scattering at 61 MeV, analysis using realistic interaction, (T) (J.W.R.)

53753 (ZFK-172) NUCLEAR SPECTROSCOPY WITH A DEUTERON BEAM. Bonitz, Manfred (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)). Mar 1969. 81p. (In German). Dep. NTIS (U. S. Sales Only).

The application of the two-dimensional technique to nuclear spectroscopic investigations of isomeric states produced with a deuteron beam is described. The pulsed-beam technique and the associated-particle method applied to protons from the (d,p) reaction were used. The following final nuclei were subject to investigations: ^{171}Er, ^{173}Yb, ^{169}Er, ^{159}Gd, ^{170}Tm, ^{208}Bi, ^{198}Au, ^{115}Cd, ^{151}Sm, ^{155}Gd, ^{160}Tb, ^{161}Gd, ^{163}Dy, ^{165}Dy, ^{167}Er, ^{171}Yb, ^{175}Yb, ^{nat}Hf + n, ^{nat}W + n, and ^{210}Bi. Five new isomeric states were found, and several isomeric decays were successfully cleared up and interpreted. In doubly odd nuclei the Ω-selection rule was discovered, and first evidence for the j-selection rule was found. (auth)

53754 SMALL-ANGLE SCATTERING OF NEUTRONS BY DEFORMED NUCLEI. Palla, G. (Central Research Inst. for Physics, Budapest). Phys. Lett.; 35B: No. 6, 477-9(5 Jul 1971).

It has recently been suggested that long-range interactions may be responsible for the "anomalous" small-angle elastic scattering by ^{232}Th and ^{238}U. It is shown that the existence of an anomaly must be considered as a misinterpretation of the effect of nuclear deformation on the values of the differential cross section. (auth)

53755 ATTEMPT TO OBSERVE EXPERIMENTALLY THE (n,γf) PROCESS IN RESONANCE NEUTRON INDUCED FISSION OF ^{235}U. Panteleev, Ts., (Joint Inst. for Nuclear Research, Dubna, USSR); Ryabov, Yu. V.; Tyan San, Kak; (and others). Phys. Lett.; 35B: No. 6, 507-8(5 Jul 1971).

The multiplicity of prompt γ radiation in resonance-neutron-induced fission of ^{235}U was measured. The energy of recorded γ rays ranged from 0.4 to 2.0 MeV. To estimate the contribution of the (n,γf) process, it was assumed that the multiplicity of prompt γ rays from fission fragments is independent of the spin of the compound state. At the accuracy achieved, it was established that the difference of the average widths of the (n,γf) process for fission through the compound states with spins $J^\pi = 3^-$ and 4^- does not exceed $\approx$3 MeV. (auth)

53756 CHARGE DISTRIBUTION AROUND A NUCLEUS WITH $Z > 137$. Panchapakesan, N. (Univ. of Delhi). Phys. Lett.; 35B: No. 6, 522-4(5 Jul 1971).

The effect of vacuum polarization for nuclei with $Z > 137$ is studied on the basis of a Bethe-Salpeter-type model that ignores spins. The increase of the effective extension of charge distribution is seen to ensure a gap in the electron energy spectrum and thus avoid a breakdown of the theory. (auth)

53757 NUCLEAR DATA SHEETS FOR A = 109. Bertrand, F. E. (Oak Ridge National Lab., Tenn.). Nuclear Data, Sect. B; 6: 1-37(Jul 1971).

Level schemes, level properties, and decay characteristics are presented for all known members of the A = 109 mass chain. This revision of the 1960 Nuclear Data Sheets is based upon experimental data received before April 1971 and contains data from $\approx$110 papers. Little spectroscopic information is available for the nuclei ^{109}Ru, ^{109}Rh, and ^{109}Sn, while ^{109}Sb is unobserved and the assignment of ^{109}Te is questionable. Spins and parities of many of the levels found in ^{109}Pd, ^{109}Ag, and ^{109}Cd are known from decay and/or reaction data. The J^π values for levels in ^{109}In are, however, undetermined except for the ground state and first excited state. The compilers have used footnotes throughout the compilation to point out discrepancies, uncertainties, and the lack of data. (auth)

53758 OPTICAL PUMPING OF NEUTRON DEFICIENT ^{187}Hg. Bonn, J.; Huber, G.; Kluge, H. J.; (and others) (CERN, Geneva. Univ., Heidelberg). Phys. Lett.; 36B: No. 1, 41-3 (9 Aug 1971).

An experimental technique for polarizing mass-separated isotopes far from stability by means of optical pumping is reported. It was used to determine nuclear moments and volume from the atomic spectrum. Results for ^{187}Hg are $I = {}^3\!/_2$, $\mu = (0.58 \pm 0.03)$ nm, $Q \approx -1$b, IS(187-198, $\lambda = 2537$ Å) $\approx$ 22 GHz. (auth)

53759 TWO-PROTON MULTIPLETS IN ^{210}Po. Tickle, R.; Bardwick, J. (Univ. of Michigan, Ann Arbor). Phys. Lett.; 36B: No. 1, 32-4(9 Aug 1971).

The ^{209}Bi(α,t)^{210}Po reaction at 45 MeV was used to study ^{210}Po. Many new levels were observed, and proton configurations are suggested for the lowest three multiplets. (auth)

53760 CONFIGURATION MIXING EFFECTS ON M1 TRANSITIONS AND MAGNETIC MOMENTS IN Pb REGION. Vergados, J. D. (State Univ. of New York, Stony Brook). Phys. Lett.; 36B: No. 1, 12-17(9 Aug 1971).

Configuration-mixing effects on M1 transitions and magnetic dipole moments are studied for ^{207}Pb, ^{207}Tl, ^{208}Pb, ^{208}Tl, and ^{206}Pb by using realistic interactions and diagonalizing large shell-model matrices. Appreciable deviations from the single-particle values are found. The results are in good agreement with experiment. (auth)

53761 MAGNETIC DIPOLE HYPERFINE STRUCTURE IN MUONIC ATOMS. Cheng, S. C.; Chen, M. Y.; Kast, J. W.; (and others) (Columbia Univ., New York). Phys. Lett.; 34B: 615-17(12 Apr 1971).

The nuclear finite-size effect in the M1 hyperfine structure of muonic atoms of ^{93}Nb and ^{139}La has been studied experimentally. Systematic differences of the finite-size effect between nuclei in which the spin and the orbital angular momentum of the odd proton are parallel or anti-parallel are discussed. (auth)

53762 EVIDENCE FOR SINGULARITY IN THE NUCLEAR ROTATIONAL BAND STRUCTURE. Johnson, A.; Ryde, H.; Sztarkier, J. (Research Inst. for Physics, Stockholm). Phys. Lett.; 34B: 605-8(12 Apr 1971).

A drastic change in the moment of inertia as a function of the rotational frequency is observed in the region of $I \approx 16$ for the deformed nucleus ^{160}Dy. This may be interpreted as a phase transition from a superfluid state to a non-superfluid state. (auth)

53763 $9/2^-$ [514] STATE IN ^{185}Re. Evans, M.; Ellis, A. E.; Leigh, J. R.; Newton, J. O. (Univ. of Manchester, Eng.). Phys. Lett.; 34B: 609-11(12 Apr 1971).

Gamma rays following the ^{186}W(d,3n)^{185}Re reaction have been observed. Evidence is given for rotational bands based on the ${}^5\!/_2{}^+$[402] and ${}^9\!/_2{}^-$[514] states. The half-life of the ${}^9\!/_2{}^-$ state has been measured and found to be 33 ± 3 ns. (auth)

53764 EVIDENCE OF MULTIPLE EXCITATIONS OF DEEP ELECTRONIC STATES IN THE INTERNAL CONVERSION SPECTRA OF THE ISOMERIC TRANSITION IN ^{109}Ag. Briancon, C.; Valadares, M.; Walen, R. (CNRS, Orsay, France). Phys. Lett.; 34B: 599-601(12 Apr 1971). (In French).

The conversion spectrum of the 88 keV nuclear isomeric transition in ^{109}Ag shows behind every conversion line the presence of several bands superimposed on the tail of the line. For the interpretation, it is necessary to take in account multiple excitation of deep electronic shells. (auth)

53765 BETA-DELAYED PROTON EMISSION FROM $^{115\ 117}$Xe AND $^{179\ 181\ 183}$Hg. Hornshoej, P. (Univ. of Aarhus, Denmark); Wilsky, K.; Hansen, P. G.; (and others). Phys. Lett.; 34B: 591-3(12 Apr 1971).

Light odd-mass isotopes of xenon (A = 115, 117) and mercury (A = 179, 181, 183) exhibit beta-delayed proton emission. No appreciable fine structure is observed in the proton spectra, which have been measured on isotope-separated samples in on-line experiments at the CERN ISOLDE facility. The proton branches observed vary in intensity from 3.4×10^{-3} (^{115}Xe) to 2.7×10^{-6} (^{183}Hg). (auth)

53766 DIRECT MEASUREMENT OF THE TOTAL PROTON DECAY WIDTH OF AN ISOBARIC ANALOG STATE. Woods, T. J.; Igo, G. J.; Whitten, C. A. Jr.; Dunlop, W.; Hoffmann, G. W.

(Univ. of California, Los Angeles). Phys. Lett.; 34B: 594-6 (12 Apr 1971).

Differential cross sections for the ^{208}Pb(p,n) reaction populating the isobaric analog state (IAS) of the ^{208}Pb ground state in ^{208}Bi have been measured at a proton bombarding energy of 30.5 MeV. The experimental technique utilized the proton ($\tilde{p}$) decay of the IAS to obtain neutron time-of-flight spectra. When these differential cross sections are compared to those obtained for the same reaction at 30.5 MeV using the pulsed-beam technique to obtain neutron time-of-flight spectra, the percentage of the IAS decay through $\tilde{p}$ channels is obtained. This comparison indicates that the $\tilde{p}$ decay of the IAS to the first three states of ^{207}Pb accounts for almost all of the IAS width (0.97 ± 0.28). (auth)

53767 EVIDENCE FOR DIPOLE–QUADRUPOLE–OCTUPOLE MIXING IN THE 902 keV $2^- \rightarrow 2^+$ TRANSITION IN ^{180}W. Konijn, J. (Instituut voor Kernfysisch Onderzoek, Amsterdam); Meijer, B. J.; Van Middelkoop, G. Phys. Lett.; 35B: No. 7, 567-9(19 Jul 1971).

From known conversion coefficients and angular correlations combined with the γ-ray decay deduced from the ^{181}Ta(p,2n)^{180}W reaction, it is found that the 1007 → 104 keV ($2^- \rightarrow 2^+$) transition in ^{180}W has mixing parameters $\delta_1 = -0.16 \pm 0.07$ and $\delta_2 = -0.64 \pm 0.17$ for M2/E1 and E3/E1, respectively. (auth)

53768 IMPLICATIONS OF THE HYPOTHESIS OF EXTINCT FISSIONING ISOTOPE IN THE PRIMITIVE METEORITES. Dakowski, M. (Joint Inst. for Nuclear Research, Moscow). Phys. Lett.; 35B: No. 7, 557-9(19 Jul 1971).

It is shown that, if the carbonaceous-chondrite xenon anomaly was really caused by fission, its progenitor was the longest living isotope of superheavy elements (SHE) with a half-life of 2×10^8y < $T_{½} \lesssim 6 \times 10^7$y. Then the search for SHE synthesized prior to the solar system formation would be fruitless. (auth)

53769 ROTATION–VIBRATION INTERACTION IN ^{152}Sm. Stokstad, R. G.; Greenberg, J. S.; Fraser, I. A.; Sie, S. H.; Bromley, D. A. (Yale Univ., New Haven). Phys. Rev. Lett.; 27: No. 11, 748-51(13 Sep 1971).

The angular-momentum dependence of the matrix element that couples the rotational and vibrational bands in deformed nuclei is determined from the measured energies of ground-state band levels. A calculation involving three bands and matrix diagonalization produces excellent overall agreement with experimental E2 transitions between the β-vibrational, γ-vibrational, and ground-state-rotational bands, and for transitions within the ground-state band. (auth)

53770 EFFECT OF CONTINUOUS SPECTRUM IN THE THEORY OF PHOTONUCLEAR REACTIONS. Bunatyan, G. G.; Fayans, S. A. (Moscow Engineering Physics Inst.). Yadern. Fiz.; 13: No. 6, 1209-18(Jun 1971). (In Russian).

On basis of the theory of the finite Fermi systems a method of accounting for the continuous spectrum in the theory of nuclear photoabsorption is developed. Formulas are obtained that enable one to extract and calculate the cross section for the absorption with transition into the continuous spectrum of the nucleons from the definite states (subshells). The (γ,n) and (γ,p) reactions for ^{91}Zr and ^{209}Bi near the threshold are calculated as examples of the approach. (auth)

53771 POLARIZATION OF THE ^{8}Li FRAGMENTS IN NUCLEAR REACTIONS INDUCED BY SLOW π^- MESONS. Varfolomeev, A. T. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 13: No 6, 1157-61(Jun 1971). (In Russian).

Nuclear fissions with production of ^{8}Li fragments were studied by means of the nuclear emulsions. A strong asymmetry in the angular distribution of electrons from the β decay of the ^{8}Li fragments with respect to the fragment momentum direction is detected. (auth)

53772 TIME-OF-FLIGHT MEASUREMENTS OF PAIR FRAGMENTS OF ^{244}Cm AND ^{252}Cf SPONTANEOUS FISSION. Barashkov, Yu. A.; Vasil'ev, Yu. A.; Maslov, A. N.; (and others). Yadern. Fiz.; 13: No. 6, 1162-9(Jun 1971). (In Russian).

Mass and kinetic energy distributions of initial fragments of ^{244}Cm and ^{252}Cf spontaneous fission are measured by the time of flight method. The mean values of the summary kinetic energy $E_k = 184.9 \pm 2.0$ MeV and of the heavy fragment mass $M_T = 143.54 \pm 0.15$ a.m.u. obtained for ^{252}Cf are in good agreement with the available data. The values of these quantities for ^{244}Cm are $E_k = 183.7 \pm 2.0$ MeV, $M_T = 139.53 \pm 0.15$ a.m.u. The yield of fragments of the ^{244}Cm symmetric fission amounts to approximately 40^{-3} from that of the most probable masses. Mass and kinetic energy distribution reveals the same main properties as for other cases of the low-energy fission. (auth)

53773 STRUCTURE OF ENERGY DEPENDENCE OF THE NEUTRON YIELD AT ^{235}U (n,f) FISSION. Prokhorova, L. I.; Smirenkin, G. N. Yadern. Fiz.; 13: No. 6, 1170-9(Jun 1971). (In Russian).

On the basis of the model of discrete variation of excited quasiparticle number in transient state of fissile ^{236}U, a possibility is studied to explain uniquely the correlating irregularities in the energy dependence of the neutron, fragment yields, and differential and integral cross sections of ^{235}U (n,f). (auth)

53774 POTENTIAL ENERGY OF ^{236}U AT ASYMMETRICAL FISSION IN PARAMETRIZATION OF THE NUCLEAR SHAPE BY MEANS OF THE CASSINI OVALOID-TYPE FIGURES. Adeev, G. D.; Gamalya, I. A.; Cherdantsev, P. A. (Tomsk Polytechnic Inst., USSR). Yadern. Fiz.; 13: No. 6, 1180-8(Jun 1971). (In Russian).

Three-dimensional energy surface of ^{236}U in the fission process is calculated using the Strutinsky method. In calculation of the shell correction a one-nucleon potential was used with three independent parameters, s, c_2 and k (k is the fragment mass asymmetry parameter). The nuclear surface shape, necessary to calculate the droplet energy, is determined by the Fermi surface in the configuration space. The contour diagrams in the s, c_2 coordinates are constructed at constant k. The lowest fission barrier occurs at k = 0.65. (auth)

53775 MEASUREMENT AND NORMALIZATION OF THE RELATIVE ^{235}U FISSION CROSS-SECTION IN THE LOW RESONANCE REGION. Deruytter, A. J. (CBNM–EURATOM, Geel, Belgium); Wagemans, C. J. Nucl. Energy; 25: No. 7, 263-72 (Jul 1971).

Measurements were performed with the Linac of the C.B.N.M. to below thermal energy for a direct normalization of fission cross sections to the 2200 m/sec reference cross-section. The measurements were performed at a well-collimated short flight-path with low repetition-rate and long burst-width of the Linac. The fission reaction rate and the neutron spectrum were determined simultaneously with solid state detectors on each side of a back-to-back ^{235}U and ^{10}B layer. From the counting-rate ratios σ_f-curves were calculated assuming a 1/v behavior of the ^{10}B(n,α)^{7}Li cross-section. Several fission integrals were calculated from the normalized σ_f curve and compared with other published results. It is shown that the large discrepancies (up to 35%) which exist between the different results can be considerably reduced by a common normalization procedure, e.g., using the fission integral $\int_{7.8\,eV}^{11\,eV} \sigma_f(E)dE = 240.2 \pm 2.1$ barn eV obtained from this measurement. (auth)

53776 γ-RAY SPECTRA AND LEVEL SCHEMES OF ^{130}Xe AND ^{132}Xe FROM (n,γ) REACTION. Groshev, L. V.; Govor, L. I.; Demidov, A. M.; Rakhimov, A. S. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 13: No. 6, 1129-34(Jun 1971). (In Russian).

Spectra of γ rays emitted at thermal neutron capture in natural mixture of Xe isotopes and in a sample enriched by ^{129}Xe are measured by means of a spectrometer with Ge(Li) detector. Energies and intensities of the γ lines selected in the spectra are determined. On basis of the obtained data, schemes are constructed of the γ transitions in even–even nuclei ^{130}Xe and ^{132}Xe to the levels lying below the energy of about 4.5 MeV. (auth)

53777 INVESTIGATION OF α DECAY ^{253}Es AND ENERGY LEVELS OF ^{249}Bk. Baranov, S. A.; Shatinskii, V. M.; Kulakov, V. M.; Rodionov, Yu. F. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 13: No. 6, 1135-40(Jun 1971). (In Russian).

Scheme of exciting states of the ^{249}Bk nucleus arising from the α decay of ^{253}Es is investigated by means of deviation of the charged particles in a magnetic field. A carefully purified einsteinium sample was used in the experiment. The α spectrum of Es is presented where more than 19 lines belonging to the ^{253}Es isotope are detected. Analysis of the experimental data indicates a presence of three rotational bands with quantum numbers $7/2^+$ [633↑], $3/2^-$ [521↑], and $5/2^+$ [642↑] in the level scheme of ^{249}Bk. The constants $\hbar^2/2J$ in the known Bohr–Mottelson formula for the rotational bands are found to be 4.7, 6.4 and 5.5 keV, respectively. (auth)

53778 ENERGY LEVELS OF ^{133}Xe. Saxena, R. N.; Sharma, H. D. (Univ. of Waterloo, Ont.). Nucl. Phys.; A171: No. 3, 593-602(1971).

The energies and relative intensities of the γ-rays following the decay of ^{133}I and ^{135}I have been measured using a Ge(Li) detector. The decay of 21 h ^{133}I was found to involve 29 γ-rays and to populate 13 excited states in ^{133}Xe. A comparison of positive-parity states found in this study has been made with those predicted by the intermediate coupling model. (auth)

53779 MAGNETIC MOMENTS OF THE 8^+ ISOMERIC STATES OF ^{90}Zr AND ^{92}Mo. Nagamiya, Shoji; Katou, Takeo; Nomura, Toru; Yamazaki, Toshimitsu (Tokyo Univ. Inst. of Physical and Chemical Research, Hirosawa, Japan). J. Phys. Soc. Jap.; 31: No. 2, 319-25(Aug 1971).

The g-factors of the $[\pi g_{9/2}^2]8^+$ states of ^{90}Zr ($t_{1/2}$ = 130 nsec) and ^{92}Mo ($t_{1/2}$ = 190 nsec) have been determined to be 1.355 ± 0.018 and 1.409 ± 0.016, respectively, by the time-differential spin rotation method in (α,2n) reactions. The results together with the known g-factors in the A = 88 region are compared with theoretical values derived from the M1 spin polarization and the mesonic exchange current. It turns out from the analysis that (1) the difference between the observed g-factors of the two 8^+ states is well accounted for by the M1 spin polarization mechanism and that (2) the mesonic effect of $\Delta g_l = 0.10$ and $\Delta g_s < 0$ explains the absolute values of the observed moments in this region. (auth)

53780 OPTICAL-MODEL ANALYSIS OF ELASTIC SCATTERING OF ALPHA PARTICLES USING A SURFACE-ABSORPTION POTENTIAL. El-Nadi, M.; El-Kharadly, L. (Univ. of Cairo). Ann. Phys. (Leipzig); 26: No. 1, 1-7(1971).

The optical model analysis has been applied to the elastic scattering of α particles on silver at energies of 18.7, 22, and 24.7 MeV. Using a volume absorption potential for the real part and a surface absorption potential for the imaginary part, the several sets of parameters giving satisfactory fits to the experimental data are obtained. The effect of varying these optical model parameters on the differential cross section is discussed. (auth)

53781 ABSOLUTE ELECTROMAGNETIC TRANSITION RATES BETWEEN MIXED QUASI-PARTICLE STATES IN ^{155}Gd. Tuurnala, T. (Helsinki Univ.). Ann. Acad. Sci. Fenn., Ser. A VI; No. 360, 1-17(1971).

Absolute transition probabilities for E1, M1, E2, and M2 gamma rays between the lowest quasiparticle states in ^{155}Gd were calculated according to the Nilsson model with pairing corrections making use of the mixed wave functions proposed previously. A detailed comparison between theory and experiment was carried out which showed that the theoretical results agree with the observed values to within a factor of two except for some magnetic dipole transitions. Reasons for these small discrepancies as well as the validity of the Nilsson model in describing more complex phenomena in odd mass nuclei are discussed. The half-life of the $^{7}/_{2}^{+}$ level at 118.0 keV was estimated to be about 2 ns. (auth) (Finland)

53782 PROPERTY OF THE 1622.41-keV LEVEL AND THE M1-E2 MIXINGS OF SOME OF THE TRANSITIONS IN ^{156}Gd. Fujioka, Manabu (Tokyo Inst. of Tech.). J. Phys. Soc. Jap.; 31: No. 3, 632-8(Sep 1971).

From the M1-E2 mixing of the 111.93-keV transition which connects the 1622.41 keV 5^+ and 1510.48 keV 4^+ levels in ^{156}Gd the former level is established to be a rotational state built on the latter. The upper limits of the magnitude of M1 component of the 262.54 and 267.07 keV transitions from the 1510.48 and 1622.41 keV levels are obtained to be q(M1) ≤ 2.0% and 6.5%, respectively. These values together with the M1-E2 mixings of other transitions deexciting the two levels are discussed. (auth)

53783 K FORBIDDEN ISOMERISM OF THE $^{11}/_{2}^{-}$[505] NILSSON ORBITAL IN THE ODD A, N = 91 ISOTONES. Kime, Milford Burton. Ithaca, N. Y.; Cornell Univ. (1971). 72p. University Microfilms Order No. 71-15,635.

Thesis.

K-forbidden isomerism due to the $^{11}/_{2}^{-}$[505] Nilsson orbital has been studied in the three odd A, N = 91 isotones ^{153m}Sm, ^{155m}Gd, and ^{157m}Dy. The half-lives of the isomers are 10.6 ± 0.3 msec for ^{153m}Sm, 31 ± 1 msec for ^{155m}Gd, and 24 ± 1 msec for ^{157m}Dy. The transitions have three degrees of K-forbiddeness and yield a hindrance factor of almost three orders of magnitude per degree of forbiddeness over the Weisskopf single particle estimates. Decay of the previously unobserved ^{153m}Sm isomer proceeds from the $^{11}/_{2}^{-}$ isomeric level at 98.4 keV through the 32.9 keV isomeric line to the $^{9}/_{2}^{+}$ level at 65.5 keV. Two transitions branch from this level, one an 11.9 keV M1 (assumed, as the L x-ray excess is all that is observed of this transition) to a $^{7}/_{2}^{+}$ level at 53.6 keV and the others a 58 keV E2 to a $^{5}/_{2}^{+}$ level at 7.5 keV level and by a 53.6 keV E2 transition to the $^{3}/_{2}^{+}$ ground state. A 7.5 keV M1 from the $^{5}/_{2}^{+}$ level is also indicated. The ^{155m}Gd decay proceeds from the $^{11}/_{2}^{-}$ state at 121.5 keV via the 13.9 keV isomeric E1 line to the $^{9}/_{2}^{+}$ state at 107.6 keV. A 21 keV E2 (seen via L x-rays) then proceeds to a $^{5}/_{2}^{+}$ state at 86.6 keV. This level decays via an 86.6 keV E1 to the $^{3}/_{2}^{-}$ ground state. Also indicated is a weak branch via a 26.6 keV E1 to a $^{5}/_{2}^{+}$ level at 60 keV which then should decay by a 60 keV M1 to the ground state. The ^{157}Dy isomer is at 199 keV. The 14.2 keV E1 isomeric transition feeds 35% of the isomeric decay to the $^{9}/_{2}^{+}$ level at 162 keV. It is assumed that the 51.5 keV isomeric transition to the $^{7}/_{2}^{-}$ level carries the remaining intensity. The $^{9}/_{2}^{+}$ level decays via a 37.3 keV E1 to the $^{7}/_{2}^{-}$ level at 148 keV. From this level a 148 keV E2 populates the $^{3}/_{2}^{-}$ ground state directly. Eighty nine percent of the $^{7}/_{2}^{-}$ level decay proceeds through an 87 keV M1 to a $^{5}/_{2}^{-}$ level at 61 keV. This then decays via a 61 keV M1 to the ground state. The thermal neutron cross-section ratio for the isomeric state ^{155m}Gd vs the ground state was found to be 0.57×10^{-3}. Qualitative evaluations of the isomeric cross-section ratio for ^{153m}Sm and ^{157m}Dy indicate that they are similar to that found for Gd. These values are several orders of magnitude below the value predicted by statistical theories. Attempts were made to find an isomer in ^{151}Nd. No isomeric activity was found in the millisecond range. Possible activities in longer half-life ranges were severely masked by the 12 min ground state decay. Thus if the cross-section ratio is of the order of that found for the other isomers, a long half-life isomer cannot be ruled out. Also, a microsecond isomer is a distinct possibility and this possibility was not ruled out either. (Diss. Abstr. Int., B)

53784 RADIATION TYPES AND INTENSITIES IN THE DECAY OF ^{235}Np. McConnon, D. (Battelle Memorial Inst., Richland, Wash.). Health Phys.; 20: No. 6, 644-5(Jun 1971).

A computation was made of energy emitted per disintegration, resulting from x rays and Auger electrons of varying intensities, following electron-capture decay of ^{235}Np. Dillman's method of calculation was used and a tabular summary made of radiations of dosimetric interest. (UK)

53785 α-PARTICLE SPECTRA FOR DECAY OF RESONANCE STATES OF ^{146}Nd. Popov, Yu. P.; Pshitula, M.; Rodionov, K. G.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 5, 913-17(May 1971). (In Russian).

Results are presented of the first measurements of the α-particle spectra for the reaction ^{145}Nd(n,α)^{142}Ce on the resonance neutrons. For the resonance states with E_0 = 4.36 and 43.1 eV the partial α-decay widths are determined for transitions to the ground and the first excited states of the daughter nucleus. On the basis of these, as well as other data for a number of nuclei, a comparison is carried out of mean values of the reduced neutron and α widths that indicates an approximate character of the Bethe hypothesis that the widths are equal. (auth)

53786 CROSS SECTIONS OF REACTIONS (n,p) AND (n,α) AT THE NEUTRON ENERGY OF 14.8 MeV. Levkovskii, V. N.; Artem'ev, O. I. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz.; 13: No. 5, 923-4(May 1971). (In Russian).

25 cross sections of the reactions (n,p) and (n,α) on the isotopes of Pd, Sb, and Te are measured by means of the activation method. 11 of the cross sections are measured for the first time. The results are compared with the systematics of (n,p) reactions. (auth)

53787 PHOTOFISSION CROSS SECTION OF ^{226}Ra. Zhagrov, E. A.; Nemilov, Yu. A.; Nikitina, N. V.; Selitskii, Yu. A. Yadern. Fiz.; 13: No. 5, 934-8(May 1971). (In Russian).

The photofission cross section of ^{226}Ra was measured in the energy range 9 to 20 MeV. The ratio of the neutron emission width to the fission width is estimated on basis of the obtained results. The value of Γ_n/Γ_f is compared with the value calculated using the statistical model. (auth)

53788 POLARIZATION PHENOMENA IN NUCLEAR REACTIONS. Proceedings of the Third International Symposium, Madison, Wisconsin, August 31–September 4, 1970. Barschall, H. H.; Haeberli, W. (eds.). Madison, Wis.; University of Wisconsin Press (1971). 956p. $15.00. (COO-7-593; CONF-700811).

Separate abstracts were prepared for 18 of the 19 invited survey papers included. One hundred and sixty-five of the 176 research contributions are listed by title only. The remaining papers have previously appeared in NSA. (J.W.R.)

For abstracts of individual papers see: 51874, 51875, 52604, 52926, 53459–53484, 53506–53509, 53530–53590, 53630–53660, 53705–53726, 53789–53793, and 53831–53860.

53789 ATTEMPT TO RESOLVE THE OPTICAL MODEL SPIN-ORBIT RADIUS ANOMALY FROM p + ^{197}Au ELASTIC SCATTERING POLARIZATION DATA NEAR THE COULOMB BARRIER. Eck, J. S. (Kansas State Univ., Manhattan); Thompson, W. J. pp 651-2 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53790 SEARCH FOR MOTT–SCHWINGER POLARIZATION IN ELASTIC PROTON SCATTERING. Roy, G.; Sherif, H.; Moss, G. A. (Univ. of Alberta, Edmonton). pp 653-4 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53791 INVESTIGATION OF THRESHOLD EFFECTS IN ISOSPIN COUPLED CHANNELS WITH POLARIZED PROTONS AND DEUTERONS. Wienhard, K. (Univ., Giessen, Ger.); Graw, G. pp 655-6 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53792 STUDY OF POLARIZATION FOR ^{128}Te(p,p) ON NEGATIVE PARITY ISOBARIC ANALOG RESONANCES. Roth, M.; Bangert, R.; Gonsior, B.; (and others) (Univ., Cologne). pp 724-5 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53793 MEASUREMENTS AND ANALYSIS OF THE VECTOR ANALYZING POWER OF ^{208}Pb(d,p)^{209}Pb NEAR THE COULOMB BARRIER. Rathmell, R. D.; Haeberli, W. (Univ. of Wisconsin, Madison). pp 791-3 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

53794 KINETIC ENERGIES OF FRAGMENTS AND ANGULAR DISTRIBUTIONS OF α PARTICLES AT TRIPLE SPONTANEOUS FISSION OF ^{252}Cf. Adamov, V. M.; Drapchinskii, L. V.; Kovalenko, S. S.; Petrzhak, K. A.; Tyutyugin, I. I. Yadern. Fiz.; 13: No. 5, 939-43(May 1971). (In Russian).

By means of silicon detectors the following quantities were measured: kinetic energies of fragments and α particles, angular distributions of α particles and variations of the kinetic energies of both fragments as well as of the light and the heavy fragment groups, at variation of E_α from 10 up to 26 MeV. Shifts are determined of the quantities $\bar{E}_k$, $\bar{E}_l$, and $\bar{E}_h$ for ternary fission from their values for binary fission. The α-particle angular distributions are approximated by Gaussians with the value of 92° for the most probable emission angle to the fragment motion direction. The maximum of the energy distribution is moved by 5 MeV to higher energies when the angle is changed from 90 to 45°, while the relative yield of high energy α particles is increased. (auth)

53795 ESTIMATE OF THE LIFETIME OF THE EXCITED COMPOUND NUCLEUS IN REACTION W(^{22}Ne,f) (EXPERIMENT). Karamyan, S. A.; Melikov, Yu. V.; Normuratov, F.; Otgonsuren, O.; Solov'eva, G. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 5, 944-9(May 1971). (In Russian).

A device is described for measuring the lifetime of compound nuclei using monocrystalic targets and observing shadows in the angular distributions of reaction products. It is shown that when exposing the W monocrystal to 174 and 98 MeV Ne ions, in the angular distributions of the fission fragments there are shadows in the directions of crystallographic axes and planes. Possibilities and advantages for measuring lifetimes of compound nuclei in reactions with heavy ions are discussed. The upper limit is presented of the lifetime of the compound nucleus for reaction W + ^{22}Ne which is found to be $\sim 10^{-17}$ sec. (auth)

53796 ANGULAR ANISOTROPY AND EFFECTS OF NUCLEON PAIRING AT THE FISSION OF ^{239}Pu BY NEUTRONS. Shpak, D. L.; Ostapenko, Yu. B.; Smirenkin, G. N. Yadern. Fiz.; 13: No. 5, 950-62(May 1971). (In Russian).

The dependence of the angular anisotropy of the ^{239}Pu(n,f) fission on the neutron energy in the range 0.05–7.20 MeV is studied. A considerable effect of the nucleon pair correlation of the superconducting type on the spectrum of the ^{240}Pu transient states is shown. The critical energy of the phase transition is estimated to be $E^*_{cr} = 12 \pm 2.5$ MeV, the energy gap is $2\Delta_0^f = 1.7 \pm 0.2$ MeV. Conclusions on the structure of the fission barrier are made. (auth)

53797 OSNOVY EKSPERIMENTAL'NYKH METODOV YADERNOI FIZIKI. (Principles of Experimental Methods for Nuclear Physics). Abramov, A. I.; Kazanskii, Yu. A.; Matusevich, E. S. Moscow; Atomizdat (1970). 560p.

The book, based on a lecture course, is divided in 4 sections. The introductory first section (Chapters 1 to 3) contains a description of radiation sources, examination of statistical fluctuations encountered in recording of measurements, and a summary review of the basic principles of the interaction of radiation and matter. The second section (Chapter 4 to 9) is devoted to physical detection methods, while measurement of the radiation energy is described in the third section (Chapters 10 to 12). In the final section (Chapters 13, 14 and the appendix) the techniques used for the determination of the activity of sources and of the interaction cross section of neutrons with nuclei are discussed; calculation of the variation of the γ spectrum emitted by excited nuclei is presented as an example of the treatment of experimental data. As accelerators and electronic devices used in these experiments are usually taught in other courses, only their basic principles are reviewed; for the same reason, instruments, such as mass spectrometers or oscillators which are not strictly related to the study of the interaction of radiation with matter, have also been excluded. (TTT)

53798 STRENGTH FUNCTIONS FOR s AND p NEUTRONS IN ^{235}U AND ^{239}Pu. Ryabov, Yu. V.; Fenin, Yu. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: No. 5, 1039-41(May 1971). (In Russian).

Average summary cross sections of fission and radiative neutron capture for ^{235}U and ^{239}Pu are analyzed for the energies from 0.1 up to 30 keV. The strength functions S_0 and S_1 for ^{235}U and ^{239}Pu are calculated on a computer by means of the least-squares method with account of the small corrections for the neutron compound elastic scattering. The values of S_0 are in agreement with the quantities obtained analyzing the observable resonances in the energy region up to 100 eV. (auth)

53799 INELASTIC ALPHA-PARTICLE SCATTERING FROM THE N = 82 ISOTONES ^{140}Ce AND ^{139}La. Baker, Francis Todd. Ann Arbor, Mich.; Univ. of Michigan (1970). 123p. University Microfilms Order No. 71-15,085.

Thesis.

Inelastic scattering of 45-MeV alpha-particles has been used to study the nuclear structure of the closed neutron shell nuclei ^{140}Ce and ^{139}La. Excitation energies and differential cross sections for observed alpha-particle groups were measured. Spectroscopic information was extracted from these data using the distorted wave Born approximation theory. Microscopic analysis of the data was performed utilizing the eigenfunctions of the generalized pairing Hamiltonian. The results of this analysis indicate that the collectively enhanced states cannot be adequately described by considering only the "valence" protons and that core contributions are therefore important. The spectrum of ^{139}La included the seniority v = 3 states which are inaccessible by proton transfer reactions. The characteristics of this spectrum are in qualitative agreement with zeroth order microscopic calculations. Transitions violating the $\Delta B = 0$ selection rule, B being the total pseudo-spin, were found to be relatively weak for both nuclei. (Diss. Abstr. Int., B)

53800 MEASUREMENTS OF ABSOLUTE FISSION PRODUCT YIELDS FROM THE THERMAL FISSION OF ^{235}U USING GAMMA-RAY SPECTROSCOPY METHODS. McLaughlin, Thomas Patrick. Tucson, Ariz.; Univ. of Arizona (1971). 118p. University Microfilms Order No. 71-14,509.

Thesis.

Calibrated fission foils and a Ge(Li)-NaI Compton-suppressed gamma-ray spectrometer have been used to determine cumulative fission product yields from the thermal neutron fission of ^{235}U. The mass chains 85, 87, 88, 91, 92, 93, 95, 97, 99, 103, 106, 131, 132, 133, 134, 135, 137, 138, 139, 140, 141, 142, 143, 144, 147, and 149 were investigated by observing the gamma-ray spectra from numerous thin ^{235}U samples. Due to the widely varying decay rates of the fission products, irradiation flux-times were varied to selectively enhance the different full-energy peaks. Half-lives of the useful fission products were in the range, 30 minutes $\leq T_{1/2} \leq$ 30 years, and their prominent gamma-rays in the range, 80 keV $\leq E \leq$ 1600 keV. This method provides an independent determination of data which was previously obtained by either radio-chemical or mass-spectrometric studies. In addition to the speed and convenience of this technique, the accuracy of yield determinations obtained for some mass chains is comparable to that of other methods and the agreement is generally good. (Diss. Abstr. Int., B)

53801 EXTERNAL MAGNETIC FIELD (Fe + Gd) AND MAGNETIC MOMENTS OF SOME EXCITED STATES (^{155}Gd,^{156}Gd).

Gaffarov, D. G.; Il'khamdzhanov, N. A.; Muminov, A. I. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 5, 81-3(1970). (In Russian).

The external magnetic field originating at Gd nucleus sites in an iron carrier was measured, making it possible to measure the magnetic moments for the short-lived nuclear states. The magnetic moments of the 4+ states at 288 and 1513 keV in ^{156}Gd were determined. For this work, samples of ^{155}Tb and ^{156}Tb were prepared by irradiating enriched ^{155}Gd and natural metallic gadolinium with 18-MeV protons. The value obtained for the magnetic moment of the 4+ state (1513 keV) differed considerably from the one found from the probability of the M1 transition but corresponds well with the theoretical prediction for the condition that this level is characterized by the structure $p_{5/2} = [413] + p_{3/2}\ [411]$. (K.S.W.)

53802 ISOTOPE SHIFT OF ^{151}Eu, ^{152}Eu, ^{153}Eu, ^{154}Eu, AND THE NUCLEAR MOMENTS OF THE RADIOACTIVE ISOTOPES ^{152}Eu AND ^{154}Eu. Heinecke, P. (Technische Univ., Hanover). Z. Phys.; 245: No. 5, 411-24(1971). (In German).

The isotope shift of the stable ^{151}Eu and ^{153}Eu, and the radioactive ^{152}Eu and ^{154}Eu isotopes and the hyperfine splitting of the ^{152}Eu isotope were investigated using a digital recording Fabry–Perot spectrometer. From isotope-shift measurements on the line λ 5765Å ($4f^76s6pz^6P_{7/2} - 4f^76s^2a^8S_{7/2}$) the relative isotope shift was derived: ^{151}Eu,0; ^{152}Eu,0.923(8); ^{153}Eu,1; ^{154}Eu,1.197(8). The results show that there is a strong increase in the change of the mean square nuclear charge radius $\delta\langle r^2\rangle$ when only one neutron is added to the 88 neutrons of the ^{151}Eu nucleus, whereas the change of $\delta\langle r^2\rangle$ between ^{152}Eu and ^{153}Eu is of the same order of magnitude as that between ^{153}Eu and ^{154}Eu. From the hyperfine splitting of the radioactive isotope ^{152}Eu in the line λ 6865Å ($4f^76s6pz^{10}P_{7/2} - 4f^76s^2a^8S_{7/2}$) the sign of the magnetic dipole moment $\mu_I(^{152}\text{Eu})$ was found to be negative, and with this result and earlier experimental data the signs of the nuclear quadrupole moments $Q(^{152}\text{Eu})$ and $Q(^{154}\text{Eu})$ could be determined to be positive. (auth)

53803 RELATIVE MEASUREMENTS OF THE LONGITUDINAL ELECTRON POLARIZATION IN THE β DECAY OF ^{90}Y AND ^{32}P. Johannsen, J.; Wisshak, K.; Loehken, R.; Rebel, H. (Univ., Heidelberg). Z. Phys.; 245: No. 5, 442-50(1971).

The ratio of the longitudinal polarization values of ^{90}Y and ^{32}P was measured at two energies by the method of Moeller scattering. The results obtained are $P(^{90}Y)/P(^{32}P) = 0.992 \pm 0.036$ at 0.725 MeV electron energy and $P(^{90}Y)/P(^{32}P) = 0.984 \pm 0.030$ at 1.0 MeV. For the decay of ^{90}Y, polarization and spectrum shape measurements are discussed in the framework of a form-factor coefficient analysis. (auth)

53804 DECAY OF ^{163}Tb. Kaffrell, N.; Herrmann, G. (Univ., Mainz). Z. Phys.; 245: No. 5, 451-70(1971). (In German).

The beta and gamma radiations of ^{163}Tb were investigated employing scintillation and semiconductor spectrometers and coincidence techniques. The sources were produced by the ^{163}Dy(n,p)^{163}Tb reaction. A half-life of 19.5 min was measured without evidence for an isomeric state in the half-life range of 2 sec to 7d; especially, a 6.5-h activity previously assigned to ^{163}Tb could not be confirmed. Seventy-six of the total of 82 gamma-ray transitions, representing 99.6% of the gamma-ray intensity, could be assigned to 23 levels in ^{163}Dy. From beta and beta–gamma coincidence measurements a Q_β value of 1.7 ± 0.1 MeV was determined. Spin and parity of $3/2^+$ are deduced for the ground state of ^{163}Tb with the Nilsson configuration [411↑]. The level at 884 keV is interpreted as a $J^\pi = 1/2^+$ state with a high contribution of the three-quasi-particle configuration p[411↑]–p[523↑]–n[523↓] because of an allowed, unhindered beta-ray transition to this level. (auth)

53805 SPECTRUM OF THE REACTION ^{208}Pb(n,γ)^{209}Pb AND SEMIDIRECT CAPTURE THEORY. Bergqvist, I.; Drake, D.; McDaniels, D. K. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 27: No. 5, 269-71(2 Aug 1971).

Measurements of the spectrum of γ rays from the reaction ^{208}Pb(n,γ)^{209}Pb were made at incident neutron energies of 9.2, 11.2, and 13.2 MeV. The observed spectral shapes disagree strongly with the predictions of compound-nucleus theory and agree quite well with those predicted by semidirect (collective) capture theory. (auth)

53806 PHOTOFISSION CROSS-SECTION OF Bi AND Pb BETWEEN 300 AND 1000 MeV. Emma, V.; Lo Nigro, S.; Milone, C. (Univ., Catania, Italy. Istituto Nazionale di Fisica Nucleare, Catania, Italy. CNR, Catania, Italy). Lett. Nuovo Cim.; 2: No. 3, 117-20(17 Jul 1971).

Cross sections were measured by using a layer of fissionable target between two glass plates, and the dose was measured with a Wilson quantameter. Cross sections per equivalent quantum and per photon were extracted for Bi and Pb targets; errors on σ_q are taken as 5%. The averaged cross sections $\bar{\sigma}_k$ obtained were 7.9 ± 1.3 mb for Bi and 3.2 ± 1.5 mb for Pb. (R.W.R.)

53807 INVESTIGATION OF LEVEL DENSITIES OF CERIUM AND STRONTIUM. Schacher, J.; Huber, P.; Wagner, R. (Univ., Basel). Helv. Phys. Acta; 44: No. 4, 487-501(7 Jan 1971). (In German).

Neutron time-of-flight spectra resulting from 14-MeV neutron bombardment of cerium and strontium were observed. Calculations based on the statistical model, with the superconductor and the Fermi-gas model used for the nuclear level density, describe the experimental spectra well. Two contributions, (n,n') and (n,2n), were included. Fermi-gas level-density parameters are obtained from fitting of the data. The analysis of the experimental spectra according to LeCouteur and Lang is also discussed. (auth)

53808 MOESSBAUER INVESTIGATIONS IN ^{195}Pt AND ^{201}Hg. Walcher, Dorothee (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 246: No. 2, 123-50(1971). (In German).

By using the Moessbauer technique the magnetic hyperfine splitting of the 130-keV transition in ^{195}Pt was observed in a Pt–Fe alloy. The derived magnetic moment is $\mu_{130} = (0.81^{+0.13}_{-0.25})\mu_N$. Isomer-shift measurements with the 130-keV and the 99-keV transitions in alloys yielded $\Delta\langle r^2\rangle_{130}/\Delta\langle r^2\rangle_{99} = 1.5 \pm 0.2$ for the ratio of the changes in the mean square charge radius of the two excited states. From isomer shifts of the 99-keV transition in compounds an estimate of $\Delta\langle r^2\rangle_{99}/\langle r^2\rangle = -(1.6^{+4.4}_{-0.9}) \cdot 10^{-4}$ is made for the change in radius of the first excited state. The line width of the Moessbauer spectrum of the 32.2-keV transition in ^{201}Hg gives a lower limit of 0.1 ns for the half-life of the second excited state. The results are compared with values for other nuclides in this mass region. (auth)

53809 STATISTICAL (α,n) REACTIONS. Tatiana-Magda, Margareta (Univ., Bucharest). Stud. Cercet. Fiz.; 23: No. 2, 161-83(1971). (In Rumanian).

The statistical model and nuclear level densities are first discussed. The experimental setup is described, including the beam characteristics, experimental geometry, targets, time-of-flight spectrometer, and method of calculating the continuous neutron spectra. Level densities and nuclear temperatures are reported for targets of ^{27}Al, ^{51}V, ^{52}Cr, ^{55}Mn, ^{56}Fe, ^{59}Co, ^{103}Rh, Ag, ^{115}In, ^{139}La, and ^{209}Bi at various energies between 13.6 and 23.6 MeV. The dependence of statistical parameters on mass number and bombarding energy is discussed, as well as level densities in (α,n) reactions, neutron cross sections of the excited nuclei, and nuclear moments of inertia. The paper concludes by considering the mechanism of (α,n) reactions at intermediate energies. (103 references) (R.W.R.)

Nuclear Theory

Refer also to abstracts 53244, 53250, 53357, 53729, and 53789.

53810 (COO–1120-123) HIGHER ORDER DEFORMATIONS AND ELECTRIC MONOPOLE TRANSITIONS. Aveledo, Claude (Kansas Univ., Lawrence. Nuclear Structure Lab.). [1970]. Contract AT(11-1)-1120. 36p. Dep. NTIS.

Internal conversion due to E0 transitions with $J \rightarrow J\ (J \neq 0)$ is considered. To facilitate comparison of the theoretical results for these transition probabilities with experiment, a dimensionless ratio X is defined. Calculational results are given for eight rare earth nuclei. The effect of the inclusion of a rotation–vibration term in the Hamiltonian on the different transition probabilities is then considered. Finally, the effects of higher-order deformations on the isotope shift of the mean square nuclear radius are discussed. (R.W.R.)

53811 (FRNC-TH–27) NILSSON HAMILTONIAN ON AN ASYMPTOTIC BASIS. Quentin, Philippe (Paris Univ., Orsay (France). Faculte des Sciences). 1970. 51p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A simple and exact method is proposed for resolving the problem of diagonalizing a Nilsson hamiltonian. An asymptotic basis is introduced which is a powerful tool for the treatment of deformed nuclei. (France)

53812 (LA-DC–12577) ELASTIC SCATTERING AND BREAKUP OF 15-MeV POLARIZED DEUTERONS. Keaton, P. W. Jr.; Armstrong, D. D. (Los Alamos Scientific Lab., N. Mex.). [1971]. 8p. (CONF-710708–1). Dep. NTIS.

From Symposium on the nuclear three body problem and related topics; Budapest, Hungary (7 July 1971).

A beam of highly polarized deuterons was obtained from the Los Alamos Scientific Laboratory polarized-ion source and accelerated by an FN tandem Van de Graaff. The cross section and four analyzing tensors for elastically scattered 15-MeV deuterons from ^{4}He, ^{52}Cr, ^{56}Fe, ^{90}Zr, and ^{197}Au were measured. The data are compared with predictions of a deuteron optical potential that is generated by folding the optical potentials of the nucleons with their internal motion in the deuteron. The tensor part of the optical potential contains a real and an imaginary part, each with a strength of about 1 MeV. The analyzing tensors for elastically scattered deuterons are sensitive to deuteron inelastic processes, such as breakup; and, perhaps, will provide a rigorous test of models. Results of a simple experiment are given which imply that a model for deuteron breakup cannot ignore the deuteron spin. (auth)

53813 (LA-DC-12780) NEW QUANTITY IN NUCLEAR MUON CAPTURE BY RADIOCHEMICAL TECHNIQUES. Silbar, R. R. (Los Alamos Scientific Lab., N. Mex.). [1971]. 4p. (CONF-710911-7). Dep. NTIS.

From fourth international conference on high energy physics and nuclear structure; Dubna, USSR (7 Sep 1971).

It is pointed out that using radiochemical techniques it will be possible to measure the capture rate to all particle-stable final states in nuclear muon capture. (J.F.P.)

53814 (LBL-209) DROPLET MODEL. Myers, William D. (California Univ., Berkeley. Lawrence Radiation Lab.). Jul 1971. Contract W-7405-eng-48. 27p. Dep. NTIS.

Some examples of the effectiveness of the liquid drop model are first considered, and then the ways in which this model and leptodermous approaches in general are related to other methods in many-body theory are discussed. Next, the example of the Hill–Wheeler box is used to show that the leptodermous approach is applicable to quantum systems even with relatively small numbers of particles. The smooth part of the total energy is then separated from the shell effects, and it is clear that an $A^{1/3}$ term must be included. After a brief introduction to the methods used to obtain the droplet model energy equation, a simplified version is used to display the most important new terms that enter. Finally, some applications of the theory are given, and it is pointed out that comparison with a much wider range of phenomena is planned once the coefficients of the theory have been better determined. (auth)

53815 (RLO-1388-140) NOTE ON THE EFFECT OF WEAK MAGNETISM ON THE MIRROR $(ft)^{+}/(ft)^{-}$ RATIO. Wilkinson, D. H. (Washington Univ., Seattle). [1971]. 6p. Dep. NTIS.

The role of weak magnetism in the mirror-asymmetry of Gamow–Teller β decay is considered. For Z = 0 the interference between weak magnetism and the chief axial term vanishes identically, while for finite Z over the range of experimental interest the contribution to the mirror asymmetry does not exceed about 2×10^{-3}, against experimental effects of the order 0.13. (auth)

53816 CONFIGURATION MIXING AND MYSTERIOUS SECOND ZERO STATES. Irvine, J. M. (Univ. of Manchester, Eng.). Phys. Lett.; 36B: No. 1, 21-3(9 Aug 1971).

A simple schematic model is used to highlight the difficulty of obtaining a low-lying excited state in doubly closed-shell nuclei having the same quantum numbers as the ground state in a nuclear-shell-model configuration-mixing calculation. (auth)

53817 SECOND CLASS CURRENTS AND MIRROR BETA DECAYS. Wolfenstein, L. (Univ. of Michigan, Ann Arbor); Henley, E. M. Phys. Lett.; 36B: No. 1, 28-31(9 Aug 1971).

Answers are given to some questions raised by Lipkin [Phys. Lett., 34B: 202(1971)] concerning the relation between mirror asymmetry in beta decay and second-class currents. Mirror asymmetry (not of electromagnetic origin) is evidence for second-class currents, even if possible CP violation is taken. A nonvanishing mirror asymmetry can be calculated in terms of single-nucleon transition matrices, but there is no unique relation between the mirror asymmetry and the matrix elements of the second-class current for free nucleons. (auth)

53818 Q-VALUE DEPENDENCE OF HEAVY-ION TRANSFER REACTIONS ABOVE THE COULOMB BARRIER. Siemens, P. J.; Bondorf, J. P.; Gross, D. H. E.; Dickmann, F. (Univ. of Copenhagen). Phys. Lett.; 36B: No. 1, 24-7(9 Aug 1971).

Heavy-ion cross sections above the Coulomb barrier exhibit a very strong dependence on reaction kinematics. When one or more particles are transferred, recoil effects are essential to understanding the Q dependence. On the average, heavy-ion transfer reactions occur preferentially at values of the kinematical variables corresponding to a classical grazing collision between "soft" or highly absorptive bodies. (auth)

53819 ASYMPTOTICALLY CORRECT SHELL MODEL FOR ASYMMETRIC FISSION. Mosel, U. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.); Maruhn, J.; Greiner, W. Phys. Lett.; 34B: 587-90(12 Apr 1971).

The two center shell model has been generalized to asymmetric configurations. This model is able to describe the correct transition from the shell structure of one nucleus to that of two fragments with unequal mass. This is illustrated by the complete level spectra for this transition. (auth)

53820 TRIAXIALITY IN NUCLEAR ROTATIONAL STATES. Tanabe, K.; Sugawara-Tanabe, K. (Yale Univ., New Haven). Phys. Lett.; 34B: 575-8(12 Apr 1971).

Non-axially symmetric deformation of a nucleus is introduced to account for the admixture of the collective rotational bands and the distribution of the yrast levels. A new rotational level scheme and an approximate formula for the yrast are derived. (auth)

53821 NUMERICAL SOLUTION OF THE FADDEEV–AMADO INTEGRAL EQUATION WITHOUT DEFORMATION OF CONTOURS. Sohre, F.; Ziegelmann, H. (Univ., Tuebingen, Ger.). Phys. Lett.; 34B: 579-80(12 Apr 1971).

A method for solving the Faddeev equation in the separable potential approximation is presented in which numerical and analytical integration are mixed to account for the singular structure of the kernel. Numerical results are compared to those obtained by the usual contour deformation method. (auth)

53822 THREE BODY CALCULATIONS. Amado, R. D. (Univ. of Pennsylvania, Philadelphia). pp 1-28 of Eighth Annual Eastern Theoretical Physics Conference Proceedings. /Rohrlich, F. (ed.). Syracuse, N. Y.; Syracuse Univ. (1969).

From eighth eastern theoretical physics conference; Syracuse, N. Y. (10 Oct 1969). See CONF-691033.

After a summary of some recent developments in the formal understanding of the three-body problem, dynamical calculations for a wide range of three-body systems are reviewed. These include n + d, d + α, and a hypothetical 0^{+} particle that decays weakly into three identical 0^{+} particles. The equations that these systems must obey are derived nonrelativistically, and their relativistic extension is indicated. Of particular interest is the final-state interaction (FSI), and how FSI information gets distributed over a three-body state. (R.W.R.)

53823 SPECTRAL DISTRIBUTIONS IN NUCLEI. French, J. B. (Univ. of Rochester, N. Y.). pp 29-54 of Eighth Annual Eastern Theoretical Physics Conference Proceedings. /Rohrlich, F. (ed.). Syracuse, N. Y.; Syracuse Univ. (1969).

From eighth eastern theoretical physics conference; Syracuse, N. Y. (10 Oct 1969). See CONF-691033.

Most theoretical work on nuclear structure involves the shell model and single-particle states. Nucleons are distributed over a finite set of these states to produce a finite vector space in which wave functions are found (the many-body problem is reduced to a spectroscopic one). The general problems which come after this reduction are considered: whether the general distribution of levels and of various kinds of transition strengths can be matched, what features of the interaction are responsible for certain features of the experimental results, whether certain group symmetries are good or badly broken, whether the reductions that have been made are allowable, etc. (R.W.R.)

53824 (d,p) REACTION ANOMALY AT THE THRESHOLD OF THE NEUTRON ANALOG CHANNEL. Graw, G.; Hategan, C. (Univ., Erlangen, Ger.). Phys. Lett.; 35B: No. 7, 541-2 (19 Jul 1971).

The difference between a cusp and the (d,p) threshold anomaly due to the presence of the single-particle l = 1 resonance in the neutron analog channel is analyzed. (auth)

53825 COMPARISON OF THE MOST OFTEN USED UNBOUND STATE WAVE FUNCTIONS IN A SQUARE WELL MODEL. Gyarmati, B. (Inst. of Nuclear Research, Debrecen, Hungary); Lovas, R. G.; Zimanyi, J. Phys. Lett.; 35B: No. 7, 549-50 (19 Jul 1971).

From a square-well-model calculation it is concluded that the use of pole functions (Gamow or Weinberg functions) or resonant-scattering wave functions as form factors in calculating nuclear reactions leading to unbound states may give rise to differences in the matrix elements when the external region contributes significantly to the integral unless an arbitrary cut-off is used. (auth)

53826 COULOMB REPULSION IN DIFFRACTION THEORY OF STRIPPING REACTIONS. Shebeko, A. V. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 13: No. 6, 1259-61(Jun 1971). (In Russian).

On the basis of the diffraction model of direct reactions an analytical expression is obtained for the (d,p)-reaction amplitude. The consideration is carried out with account of the Coulomb repulsion in the initial and final channels of the reaction. (auth)

53827 APPEARANCE OF THE ROTATIONAL SPECTRUM IN THE NUCLEAR PHONON MODEL. Medvedev, B. I. (Moscow Metallurgical Inst.). Yadern. Fiz.; 13: No. 6, 1192-5(Jun 1971). (In Russian).

Possible appearance of the rotational spectrum in the nuclear phonon model is considered. It is shown that the rotational spectrum arises in the system of the dipole phonons in presence of a strong anharmonism. The moment of inertia is found. (auth)

53828 LOW ESTIMATE FOR THE SELF-ENERGY OF SYSTEM WITH A HARD CORE. Savchenko, O. Ya. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz.; 13: No. 6, 1196-8(Jun 1971). (In Russian).

A simple method is presented to get a low estimate for the energy of the system of particles with a hard core. The method is used for upper estimate of the bound energy of the nucleons in a nucleus where the nucleon cores are almost compactly packed. (auth)

53829 CONTRIBUTION FROM VARIOUS TYPES OF THE NUCLEAR INTERACTIONS TO THE NUCLEAR BINDING ENERGY. Sadovoi, A. A. Yadern. Fiz.; 13: No. 6, 1199-1208 (Jun 1971). (In Russian).

The Talmi–Moshinsky transformation is used to calculate the matrix elements (ME) of various local nucleon–nucleon potentials in the K-harmonics method. The result is that in the most general case the ME between arbitrary angular harmonics may be expressed in terms of simple integrals. Explicit expressions are presented for ME of central, tensor, spin-orbit, and l^2-dependent nuclear forces. The obtained formulas make the calculations of ME of the nuclear potential energy much simpler, and, besides, enable one to investigate the contributions from various types of the nuclear interactions to the nuclear binding energy. (auth)

53830 OFF-SHELL T MATRIX CORRESPONDING TO A SUM OF COULOMB AND SEPARABLE POTENTIALS BY EXPANSION IN O(4) HARMONICS. Zachary, W. W. (Naval Research Lab., Washington, D. C.). J. Math. Phys. (N. Y.); 12: No. 7, 1379-86 (Jul 1971).

Using a group-theoretic approach similar to methods previously used in the pure Coulomb problem, representations are derived for the off-shell "nuclear" T matrix—the difference between the complete T matrix and the Coulomb T matrix—corresponding to the sum of Coulomb and separable potentials, in particular, for the sum of Coulomb and Yamaguchi potentials. These representations have some analogous properties to those representations already known for the pure Coulomb T matrix, especially in the on-shell limit. (auth)

53831 POLARIZATION AND SYMMETRY PROPERTIES. Weidenmueller, Hans A. (Univ., Heidelberg. Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 15-28 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

The importance of nuclear polarization experiments in testing symmetry properties of the fundamental interactions and conversely, the importance of symmetry principles in correlating and analyzing nuclear polarization experiments, are discussed. The status and consequences of P and T invariance, and the consequences of isospin invariance are reviewed. (63 references) (J.W.R.)

53832 POLARIZATION PHENOMENA IN NUCLEAR REACTIONS. Feshbach, Herman (Massachusetts Inst. of Tech., Cambridge). pp 29-38 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

Two aspects of polarization phenomena in nuclear reactions are reviewed. The first aspect discussed is the problem of the polarization observables and their representation in terms of partial waves. The second is the use of polarization experiments for the probing of nuclear structure and nuclear reaction mechanisms. (21 references) (J.W.R.)

53833 DESCRIPTION OF POLARIZATION AND SUGGESTIONS FOR ADDITIONAL CONVENTIONS. Darden, S. E. (Univ. of Notre Dame, Ind.). pp 39-56 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

The expressions relating polarization, cross sections, and analyzing power are summarized, using spherical and Cartesian tensors most frequently employed in the literature. Emphasis is placed on coordinate systems and the relation between analyzing power and polarization produced in the inverse reaction. For the spherical tensors the expressions are generalized to include the effect of third-rank polarization. Simple surfaces containing multipole deformations are used to aid in vizualizing second- and third-rank polarization. (auth)

53834 NUCLEON–NUCLEON INTERACTION. Mac Gregor, Malcolm H. (Univ. of California, Livermore). pp 57-72 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

The present understanding of the nucleon-nucleon interaction is surveyed. The experimental data are reviewed and some recent theoretical work is discussed. Some recent data on polarization and cross sections of elastic interactions are highlighted. (39 references) (J.W.R.)

53835 THREE- AND FOUR-NUCLEON SYSTEM. McKee, J. S. C. (Univ. of Birmingham, Eng.). pp 73-93 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

The available experimental data on polarization phenomena in three- and four-nucleon systems is surveyed. (55 references) (J.W.R.)

53836 FIVE-NUCLEON SYSTEM AND THE CALIBRATION OF POLARIZATION OF BEAMS OF NEUTRONS, PROTONS, AND DEUTERONS. Striebel, H. R. (Univ., Basel). pp 95-106 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

The recent experimental work on polarization effects in five-nucleon systems is surveyed. This work includes nucleon–^{4}He elastic scattering, ^{3}He(d,p) and T(d,n) reactions, and deuteron scattering from ^{3}He and T. In addition, the possibilities of calibrating the polarization of nucleons and deuterons are discussed. (58 references) (J.W.R.)

53837 POLARIZATION AND COMPOUND NUCLEAR STATES IN LIGHT NUCLEI. Plattner, G. R. (Univ., Basel). pp 107-30 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

Several experiments on polarization and compound nuclear states in light nuclei which have attracted strong interest recently are surveyed in detail. These studies include elastic scattering from spin-zero nuclei, elastic scattering from nuclei with spin, and nuclear reactions. Some of the problems associated with this type of nuclear spectroscopy are reviewed, and possibilities for overcoming them are discussed. (154 references) (J.W.R.)

53838 NUCLEON–NUCLEUS OPTICAL MODEL POTENTIAL. Perey, F. G. (Oak Ridge National Lab., Tenn.). pp 131-42 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO–7-593; CONF-700811.

A few areas of optical model studies which are of current interest are reviewed. An optical-model analysis of proton scattering by ^{208}Pb at 30 to 60 MeV is discussed in detail. (J.W.R.)

53839 ELASTIC SCATTERING OF DEUTERONS AND HEAVIER PROJECTILES. Johnson, R. C. (Univ. of Surrey, Guildford, Eng.). pp 143-53 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

The recent data on polarization effects in the elastic scattering of deuterons, tritons, and helium-3 are reviewed. The value of using polarized beams in experiments performed for the formulation and testing of optical-model parameters is discussed. (J.W.R.)

53840 PROTON INELASTIC SCATTERING. Satchler, G. R. (Oak Ridge National Lab., Tenn.). pp 155-77 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

The results of recent polarization measurements, including the so-called spin-flip measurements, on the inelastic scattering of protons are reviewed. These indicate that a "collective" or deformed potential model gives a good account of most of the data, provided both the absorptive and the spin-orbit coupling components of the optical potential are deformed. For the latter, partly on experimental and partly on theoretical grounds, the so-called Thomas form of deformed spin-orbit coupling is to be preferred over the simplified form used earlier. Further, there are indications that the spin-orbit part should have a greater deformation than the central part. A microscopic description of the polarization in terms of shell-model wave functions and effective nucleon-nucleon interactions has not so far been successful. It is most likely that nucleon-nucleon spin-orbit and tensor interactions will have to be introduced. (auth)

53841 ISOBARIC ANALOG RESONANCES. Graw, G. (Univ., Erlangen, Ger.). pp 179-203 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

Polarization experiments on proton scattering near isobaric analog resonances are discussed. The usefulness of these experiments in analyzing nuclear structure and the nuclear reaction mechanism is pointed out. Some recent measurements of polarization and analyzing power for both elastic and inelastic scattering are reviewed. (J.W.R.)

53842 THEORY OF TRANSFER REACTIONS. Goldfarb, L. J. B. (Univ. of Manchester, Eng.). pp 205-34 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

The theoretical treatment of polarization in (d,p) reactions is described. Some of the current theoretical developments are examined in detail. (J.W.R.)

53843 POLARIZED NEUTRONS ON POLARIZED TARGETS. Postma, H. (Rijksuniversiteit, Groningen, Netherlands). pp 373-87 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

Several recent developments which have increased possibilities for nuclear reaction and scattering studies using polarized beams and polarized targets are discussed. Some developments in cryogenics relating to nuclear orientation are described. Techniques for the production of polarized neutrons are also described. Some of the available experimental data on polarized neutron interactions with polarized targets are reviewed. (J.W.R.)

53844 COMPLETE DETERMINATION OF THE SCATTERING AMPLITUDES FROM POLARIZATION MEASUREMENTS. Simonius, M. (Eidgenoessische Technische Hochschule, Zurich). pp 401-5 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53845 RELATIONSHIP BETWEEN POLARIZATION, ANALYZING POWER, AND ASYMMETRY. Yazaki, K. (Tokyo Univ.); Tanifuji, M. pp 406-7 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53846 ANGULAR CORRELATION THEORY FOR REACTIONS WITH POLARIZED BEAMS. Bergdolt, G. (Laboratoire de Physique Nucleaire et Physique des Accelerateurs, Strasbourg). pp 408-10 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53847 FORMALISM FOR $A(\vec{d},\vec{n})B$ AND $A(\vec{d},\vec{p})B$ POLARIZATION TRANSFER REACTIONS. Gammel, J. L.; Keaton, P. W. Jr.; Ohlsen, G. G. (Los Alamos Scientific Lab., N. Mex.). pp 411-14 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53848 CONSIDERATIONS ON POLARIZED NEUTRON PRODUCTION BY $(\vec{d},\vec{n})$ POLARIZATION TRANSFER REACTIONS AT ZERO DEGREES. Ohlsen, G. G.; Keaton, P. W. Jr.; Simmons, J. E. (Los Alamos Scientific Lab., N. Mex.). pp 415-17 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53849 FORMALISM FOR $A(\vec{p},\vec{p})A$ AND $A(\vec{d},\vec{d})A$ POLARIZATION TRANSFER. Ohlsen, G. G.; Keaton, P. W. Jr. (Los Alamos Scientific Lab., N. Mex.). pp 418-21 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53850 FORMALISM FOR SPIN-3/2 BEAMS. Keaton, P. Jr. (Los Alamos Scientific Lab., N. Mex.). pp 422-4 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53851 CALCULATIONS CONCERNING SCATTERING STATES OF THE FOUR-, FIVE-, AND SIX-NUCLEON SYSTEMS. Hackenbroich, H. H. (Univ., Cologne). pp 492-3 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53852 POSSIBILITY OF DETERMINING ABSOLUTE PARITIES FROM AN S-MATRIX ANALYSIS OF DATA FROM REACTIONS LIKE $^{13}C(\alpha,n)^{16}O$. Seyler, R. G. (Ohio State Univ., Columbus). pp 624-5 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53853 PROTON POLARIZATION ANALYSIS WITH A SURFACE TERM IN THE REAL PART OF THE OPTICAL POTENTIAL. Sinha, B. C. (King's Coll., London); Burge, E. J.; Edwards, V. R. W.; Tait, W. H. pp 643-5 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53854 NUCLEAR STRUCTURE EFFECTS ON ASYMMETRY OF PROTON INELASTIC SCATTERING. Raynal, J. (CEN, Saclay, France). pp 687-9 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53855 POLARIZATION IN PROTON ELASTIC SCATTERING NEAR ISOBARIC ANALOG RESONANCES. Pisent, G. (Univ., Padua). pp 721-3 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53856 DEUTERON D-STATE EFFECT AND j-DEPENDENCE IN VECTOR POLARIZATION FOR (d,p) REACTIONS. Santos, F. D. (Laboratorio de Fisica e Engenharia Nucleares, Sacavem, Portugal). pp 758-62 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53857 j-DEPENDENCE OF VECTOR-ANALYZING POWER OF (d,p) REACTIONS. Tolsma, L. D.; Verhaar, B. J. (Eindhoven Univ. of Tech., Netherlands). pp 765-6 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53858 QUADRATIC SPIN-ORBIT EFFECTS ON SOME $0^+ \rightarrow 0^+$ (^{3}He,t) REACTIONS. Raynal, J. (CEN, Saclay, France). pp 798-800 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53859 PRECISE METHOD FOR THE DETERMINATION OF SECONDARY STANDARDS FOR DEUTERON ANALYZING TENSORS. Keaton, P. W. Jr.; Armstrong, D. D.; Lawrence, G. P.; McKibben, J. L.; Ohlsen, G. G. (Los Alamos Scientific Lab., N. Mex.). pp 849-51 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53860 RAPID METHOD FOR THE MEASUREMENT OF ANALYZING TENSORS IN REACTIONS INDUCED BY POLARIZED DEUTERONS. Lawrence, G. P.; Ohlsen, G. G.; McKibben, J. L.; Keaton, P. W. Jr.; Armstrong, D. D. (Los Alamos Scientific Lab., N. Mex.). pp 855-7 of Polarization Phenomena in Nuclear Reactions. /Barschall, H. H. (ed.). Madison, Wis.; Univ. of Wisconsin Press (1971).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (Aug-Sep 1970). See COO-7-593; CONF-700811.

53861 ALGEBRAICHESKIE METODY V TEORII YADRA. (Algebraic Methods in Nuclear Theory). Vanagas, V. Vilnyus, USSR; Izdatel'stvo Minitis (1971). 380p.

The book is intended for the use of scientists interested in the application of the group theory to many-particle systems. Only selected problems, related to the supermultiplet approximation, and more specifically, to the use of the unitary symmetry properties of the zero order Hamiltonian model of the nucleus, have been treated. The theory based on the algebraic methods of symmetrical and classical continuous groups attempted to explain characteristics of nuclear spectra on the basis of the kinematic properties of the model nuclear wave function. The subjects treated include allowed β transitions in the supermultiplet approximation, nuclear magnetic dipole moments, energy spectra of SU_3-invariant interactions, dependence of the energy level splitting on the quantum number of the orbital momentum, etc. (TTT)

53862 DECOMPOSITION OF CHARACTERISTICS OF PARTICLES EMITTED IN TWO STAGES OF NUCLEAR SPALLATION INTO PARTIAL CHARACTERISTICS. Levkovskii, A. A.; Serebrennikov, Yu. I. (Leningrad Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 8, 95-9(1970). (In Russian).

A method of analysis of experimental data on secondary particles that correspond to two stages of nuclear fission is set forth. Angular isotropy in the scattering of particles emitted by a residual nucleus in its center-of-mass system is assumed. Polar-coordinate graphs simplify the determination of the velocity of the particles as a function of the experimentally measured radius. Tables are given for a universal correction of the photoemulsion geometry used in fission experiments. (tr-auth)

53863 RADIATIVE CAPTURE OF ORBITAL ELECTRONS. Zon, B. A. (Voronezh State Univ., USSR). Yadern. Fiz.; 13: No. 5, 963-74(May 1971). (In Russian).

General expressions are obtained for the inner brehmsstrahlung probabilities of the electron capture from any shell, as well as for various correlation and polarization effects. The obtained formulas are used for numerical calculations and are compared with experimental data for ^{37}Ar, ^{119}Sb, ^{165}Er. (auth)

53864 ACCOUNT OF HIGHER HARMONICS IN THE HYPERSPHERICAL FUNCTION METHOD. Sadovoi, A. A.; Simonov, Yu. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: No. 5, 990-1004(May 1971). (In Russian).

A method is developed to construct the higher harmonics in terms of the hyperspherical functions (K-harmonics) proposed for solution of the many-body problem. The method allows one to obtain harmonic polynomials of arbitrary degree K, satisfying the Pauli principle and possessing definite values of the total orbital moment, spin and isospin as well as their projection. The expression for the matrix element from one-particle and two-particle operators is described in a simple form convenient for calculations and close to corresponding expressions of the usual shell model. (auth)

53865 THREE-BODY PROBLEM IN THE OSCILLATOR BASIS. Macharadze, T. S.; Mikhelashvili, T. Ya. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz.; 13: No. 5, 981-9(May 1971). (In Russian).

Total classification of the intrinsic states of three particles moving in the harmonic oscillator field is carried out. Expressions for the fractional parentage coefficients are presented that enable one to construct the three-particle wave function with an arbitrarily given symmetry. General problems are discussed of the calculation method based on the expansion of the wave function over the total orthonormalized set of wave functions of the translation—invariant shell model. Calculations are performed for the case of a square well potential. A binding energy of 8.73 MeV is obtained for the ^{3}H nucleus. (auth)

53866 ON AN EXACT SOLUTION OF THE BETHE–GOLDSTONE EQUATION FOR FINITE NUCLEI. Dzhibuti, R. I. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz.; 13: No. 5, 1008-15 (May 1971). (In Russian).

The Bethe–Goldstone equation for finite nuclei is solved exactly with an effective potential resulting from modification of the Serber force. It is shown that the obtained analytic form of the correlated pair relative motion wave function is reasonable. The results are applied to study the structure of the energy spectrum of the ^{16}O nucleus. Diagonalizing the Brueckner t matrix in the basis of spherical field functions with application of the Brueckner–Hartree–Fock method, the ^{16}O nuclear levels are calculated. Reasonable agreement with the experimental data is obtained. (auth)

53867 POLARIZATION OF NUCLEONS ELASTICALLY SCATTERED ON NUCLEI. Pasechnik, M. V.; Prokopenko, V. S. (Inst. of Nuclear Research, Kiev). Yadern. Fiz.; 13: No. 5, 1026-31(May 1971). (In Russian).

Nucleon elastic scattering at ~4 to 30 MeV on a large number of nuclei within the $40 \leq A \leq 210$ region is considered. The connection is established between the differential cross section of nucleon elastic scattering and the angular dependence of polarization in the process of elastic scattering. This connection leads to reasonable agreement with experiment for protons but to considerably worse agreement for neutrons. The question on the applicability limits of the formula obtained is discussed. (auth)

53868 CLUSTER-TRANSFER IN NUCLEAR COLLISION. Abelishvili, T. L. (Tbilisi State Univ., USSR). Yadern. Fiz.; 13: No. 5, 1042-51(May 1971). (In Russian).

The cluster-transfer is analytically calculated in a nuclear collision in the framework of quasiclassical approximation at energies below and above the Coulomb barrier. (auth)

53869 ANGULAR CRITERIA OF CHOICE OF COHERENT INTERACTIONS OF PARTICLES WITH COMPLEX NUCLEI. Azimov, S. A.; Gulyamov, U. G.; Gulyamov, K. G.; Chernov, G. M. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 6, 47-52(1970). (In Russian).

Experiments were undertaken for the purpose of developing new effective angular criteria of selection of reactions of coherent particle generation with complex nuclei. A formula is developed which provides a satisfactory estimate of the upper limits of a longitudinal impulse of secondary particles for the pion reaction $\pi^- + A \rightarrow A + \pi^-\pi^-\pi^+$ and for the proton reaction $p + A \rightarrow A + p\pi^+\pi^-$. Approximately equal numbers of these two coherent events were observed, evidencing good agreement with well-chosen values of the upper limits of longitudinal and transverse impulses of secondary particles. (K.S.W.)

53870 EXCITED STATES OF DEFORMED ODD-MASS NUCLEI. Begzhanov, R. B. (Inst. of Nuclear Energy, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 5, 62-5(1970). (In Russian).

This article gives a short review of various papers devoted to models which explain some of the properties of odd-mass nuclei. The energies of excited states of deformed odd-mass nuclei are mathematically defined. (K.S.W.)

53871 NUMERICAL METHOD OF ANALYZING BETA-DECAY MEASUREMENTS AND APPLICATION TO THE $1^- \rightarrow 0^+$ TRANSITIONS OF ^{170}Tm, ^{186}Re, AND ^{210}Bi. Loehken, R. (Univ., Heidelberg); Rebel, H.; Schatz, G. Z. Phys.; 245: No. 5, 425-41(1971).

A numerical method is proposed for determining nuclear matrix elements from beta-decay measurements. The method is based on the least-squares principle, and its main application is the analysis of beta-ray spectra. Its main result is to show that a spectrum shape measurement usually determines only a second-order polynomial of the matrix elements to a high precision whereas each of the matrix elements can vary within wide limits. The method is applied to the first-forbidden nonunique transitions ($1^- \rightarrow 0^+$) of ^{170}Tm, ^{186}Re, and ^{210}Bi (RaE). The 3 contributing matrix elements and their ranges of error are determined from recent measurements. (auth)

53872 SYMMETRY BREAKDOWN IN THE NUCLEAR-FISSION PROCESS. Ohta, K. (Tokyo Univ.). Lett. Nuovo Cim.; 2: No. 3, 95-8(17 Jul 1971).

An explanation for the breakdown of symmetry in nuclear fission is given. For a slightly excited nucleus to divide into two unequal fragments, asymmetric deformations must develop in the dynamic descent from the saddle point to the scission point. At saddle the nucleus is cold and may be in the symmetric mode. As fission proceeds, the Coulomb energy between the two nascent fragments decreases. Free-energy arguments show that, in the vicinity of the scission point, there exists only the asymmetric mode of oscillation, which leads to divisions into unequal fragments. (R.W.R.)

53873 GEOMETRIC SHAPES OF LIGHT NUCLEI. Specht, J. (Kernforschungszentrum, Karlsruhe, Ger.). Lett. Nuovo Cim.; 2: No. 3, 126-8(17 Jul 1971).

An empirical formula for the deformation parameters of light nuclei is obtained and compared with experimental data for quadrupole and hexadecapole deformations. It is also shown that the deformed nuclei touch the surface of the two next-lying double-magic nuclei. (R.W.R.)

53874 INFLUENCE OF THE CHEMICAL ENVIRONMENT ON β DECAY. Alder, K.; Baur, G.; Raff, U. (Univ., Basel). Helv. Phys. Acta; 44: No. 4, 514-18(7 Jan 1971).

The influence of a change of the electron screening on β decay is discussed. The results are used to calculate the change of the half-life of various β decays in different chemical environments. (auth)

53875 GRUPPENTHEORETISCHE METHODEN IM SCHALENMODELL DER KERNE. TEIL II. (Group-Theoretical Methods for the Shell Model of Nuclei. Part II). Doenau, Friedrich; Flach, Guenter. Berlin; Akademie-Verlag (1969). 256p. 42.- M.

Application of the shell model involving many particles encounters two characteristic difficulties. First, an asymmetrical set of wave functions must be classified and constructed. Second, spin coupling must be handled to compute matrix elements. The two problems are discussed in detail. Traditional procedures have recently been enriched by graphical techniques. Application of these modern techniques not only leads to simplification of computations but also to solubility of all problems involving the shell model. (H.B.G.)

53876 NUCLEAR CORE RENORMALIZATION AND SCALING PROPERTIES OF SOME RESIDUAL INTERACTIONS. Camiz, P. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); D'Andrea, A.; Oliveri, E.; Scalia, M. Lett. Nuovo Cim.; 2: No. 1, 33-5(3 Jul 1971).

The coupling constants of a generalized pairing interaction with A dependence are considered. It is assumed that the presence of the valence nucleons induces a modification of the core such that the coupling constants may be written $G_i(A) = G_i(A_0)\,[1 + \lambda f_i(A - A_0)]$, where λ is a renormalizing parameter and f_i depends on the form of the interaction. The model is based on the hypothesis that the leading modification experienced by the core when nucleons are added can be described by a pure variation of the core radius; other effects, such as deformations, are neglected. It is shown that $dk/k = \lambda(A - A_0)$, where k is the oscillator constant and A_0 is the core mass number. (R.W.R.)

53877 QUASI-ELASTIC (p,n) SCATTERING. Rahman, M. (Atomic Energy Centre, Dacca, Pakistan); Sen Gupta, H. M. Nucl. Sci. Appl., Ser. B; 5: 4-6(Oct 1969).

A survey of the theoretical interpretation of quasi-elastic (p,n) scattering is made. Inclusion of a term like $t \cdot T$ in the optical potential gives rise to the quasi-elastic (p,n) process. The effect of various form factors used in the analyses on the (p,n) angular distribution is also discussed. (auth)

53878 REAL PART OF A NONLOCAL OPTICAL MODEL POTENTIAL. Suhrabuddin, S. (Univ. of Dacca, Pakistan); Chowdhury, S. M. M. R. Nucl. Sci. Appl., Ser. B; 5: 7-10 (Oct 1969).

The variation of the real part of the well depth in the case of elastic scattering of nucleons by a nucleus as a function of target mass is examined in the framework of the energy-independent nonlocal potential. Analysis indicates that the well depth for neutrons is almost constant with the mass number A and the well depth for protons may be obtained from that of neutrons by using the relation $V^p = V^n + \Delta(Z/A_{1/3})$, where V^p and V^n correspond to proton and neutron respectively, and $\Delta = 1.005$ for a nonlocal potential with Gaussian kernel and $\Delta = 0.817$ for a potential with Yukawa kernel. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 51642, 51752, 54039, and 54254.

53879 (70-CNA-618) PICKERING GENERATING STATION. Progress Report. McCredie, J. (Hydro-Electric Power Commission of Ontario, Toronto). 1970. 14p. (CONF-700564-15). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

Construction progress during 1969–1970 is described. Salient design features are reviewed. (J.M.J.)

53880 (70-CNA-619) GENTILLY STATUS REPORT, MAY 1970. Dahlinger, A. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 13p. (CONF-700564-3). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

Construction progress during 1969–1970 is described. Salient design features are reviewed. (J.M.J.)

53881 (70-CNA-621) STATUS OF THE RAJASTHAN ATOMIC POWER PROJECT. Stevens, J. E. S. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 1970. 10p. (CONF-700564-19). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

Progress on the construction of both CANDU-type reactors at Rajasthan is described briefly. A schedule for completion of systems is given. (J.M.J.)

53882 (70-CNA-622) STATUS OF THE KARACHI NUCLEAR POWER PROJECT. Graham, R. J. (Canadian General Electric Co., Ltd., Peterborough (Ontario)). 1970. 7p. (CONF-700564-6). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

Progress on the construction of the CANDU-type reactor at Karachi is described briefly. (J.M.J.)

53883 (70-CNA-630) CANADIAN POWER REACTORS. Horton, E. P. (Hydro-Electric Power Commission of Ontario, Toronto). 1970. 6p. (CONF-700564-9). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

Construction of the Douglas Point CANDU-type reactor is described briefly. Schedules for completion of the Pickering, Karachi and Gentilly Reactors are given in a single bar graph. (J.M.J.)

53884 (70-CNA-647) MARKETING OF NUCLEAR POWER PLANTS. Aikin, A. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 1970. 8p. (CONF-700564-1). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

Marketing of CANDU-type reactors is discussed. Possible customers are mentioned. Problems are detailed. Services offered by AECL are described. (J.M.J.)

53885 (A/CONF.49/P-9) PERSPECTIVES OF DEVELOPMENT OF NUCLEAR ENERGY IN THE PEOPLE'S REPUBLIC OF BULGARIA. Ruskov, Simeon May 1971. 10p. (In Russian). (CONF-710901-483). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The reserves of Bulgaria in organic fuel (coal, gas, petrol) and in hydraulic energy are limited and in order to fill up the deficit of its energetic balance, our country has to bend towards the nuclear energy. The building of the first Bulgarian Nuclear Power Station near Kozloduy, a small Danube riverside city, started in 1970. The capacity of this station will be 880 MW(el) two water moderator reactors, each of 440 MW(el). In 1972 will begin the extension of the station with another 880 MW(el), increasing the total capacity to 1760 MW(el). As the channel for the steam condensation is foreseen for a 2000 MW(el) Nuclear Power Station, it is possible to proceed in the future to a further increasing of its capacity. In 1980 another Nuclear Power Station should be built with a capacity of 1000 MW(el). It is possible, after reconsideration of the estimations, to increase the capacity of this station to 2000 MW(el). However, it is not yet definitely decided on the basis of which reactor type should be developed in the future of the Nuclear Power Station System. The forecasting of electricity consumption in Bulgaria for the year of 2000 has been calculated to be about 200 billions of kWh. It is expected, that 60% of this energy will be from nuclear source. (auth)

53886 (A/CONF.49/P-135) PROJECTED ROLE OF NUCLEAR ENERGY IN MEETING THE FUTURE ENERGY NEEDS OF AUSTRALIA. Carr, F. H. (Australian Atomic Energy Commission, Sydney). May 1971. 27p. (CONF-710901-166). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A summary is given of the fuel resources including a description of the development of new deposits of oil, gas, and nuclear fuels over the last several years. Existing electricity generating arrangements are described for each State including the types of fuel used and the outlook for the use of black and brown coal, oil, hydro, and natural gas. Electricity demand and demand growth are summarised. The introduction of nuclear power into Australia is discussed. The proposed nuclear power station at Jervis Bay will be the first commercial nuclear plant installed and the station is expected to be in operation by 1976. Nuclear power should be competitive with conventional stations in the majority of States by the mid nineteen eighties when additional nuclear power stations are expected to be in operation. (10 references) (auth)

53887 (A/CONF.49/P-155) CANADIAN NUCLEAR INDUSTRY. Howieson, J. (Canadian Westinghouse Co., Ltd., Hamilton (Ontario)). May 1971. 12p. (CONF-710901-173). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Industrial planning in Canada is based on the projections of the growth of the nuclear power requirements in the country—with some small allowances for export. Other major factors are the projections of Canadian resources of manpower and capital. These resources and projections are summarized for the "direct" nuclear industries. These cover the production or fabrication of heavy water, zirconium, steam generators, pumps, fueling machinery and other reactor components—and, of course, reactor design. "Indirect" industry—the manufacture of turbines, electrical generators, transformers, switchgear, control and instrumentation, plus construction and service industries—is also discussed. The cumulative expenditures in the next 20 years on CANDU systems in Canada is predicted at $\$10^{10}$ as against $\$10^{9}$ in the last 20 years. The information presented shows that the choice of the CANDU system should be specially attractive to other countries with a growing industrial capability similar to that of Canada. (5 references) (auth)

53888 (A/CONF.49/P-156) FUEL FOR CANADIAN POWER REACTORS. Haywood, L. R.; Robertson, J. A. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.); Pawliw, J. (Canadian General Electric Co., Ltd., Peterborough (Ontario)); Howieson, J.; (and others) (Canadian Westinghouse Co., Ltd., Hamilton (Ontario)). May 1971. 15p. (CONF-710901-174). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Canada's heavy-water-moderated power reactors (CANDU reactors) fueled with natural uranium dioxide are known for their low fuel cost and good neutron economy. The simple design of the fuel bundles permitted economic mass production at an early stage and facilitated irradiation schedules that give uniform burnup. The excellent performance of this fuel in pressurized heavy water can also be exploited in boiling-light-water and organic coolants. Fuels other than UO_2 are being developed for potential savings. The Hydro-Electric Power Commission of Ontario (Canada's major nuclear utility) buys natural uranium on long-term contracts and procures fabrication of finished fuel on shorter-term contracts. Methods for scheduling the fuel through the reactors, using computer programming, have been developed from work done by the reactor designers. Fixed-price contracts for 19,000 bundles (375 tonnes U) for the four-unit 2000 MW(e) Pickering Generating Station yield a total finished fuel cost of $44/kg U (1967 Canadian dollars) or an equilibrium fueling cost of 0.7 m$/kWh. For accounting, spent fuel is assigned zero value, so its future sale or use would constitute a bonus. The current price for natural-UO_2 28-element 10-cm-diameter CANDU fuel bundles (excluding only the U_3O_8 cost) is

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about $30/kg U (1970 Canadian dollars) and is expected to decrease by one-third by 1980. This price is one-third or one-fourth that of fuel assemblies for light-water reactors. The simplicity of the CANDU fuel design accounts for much of the price differential. There are no channel or control-rod components in CANDU fuel; the short bundle and large element diameter contribute significant cost reductions. The involvement of only natural uranium accounts for the remainder. Experience in Canada is sufficiently extensive to establish confidence in the reality of the fabrication prices. Nearly half a million elements had been fabricated by the end of 1970. (14 references) (auth)

53889 (A/CONF.49/P-188) ITALIAN EXPERIENCE ON FUEL PERFORMANCE. Ariemma, A.; Belelli, U. (ENEL, Rome, Italy); Bionda, E. (CAMEN, Pisa, Italy); Bozzoni, T.; (and others) (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1971. 18p. (CONF-710901-190). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The performance of fuel assemblies in nuclear reactors is analyzed in the light of the experience acquired by ENEL with the operation of Garigliano, Latina and Trino Vercellese power plants, and by CNEN and Agip Nucleare within their development programs. The performance of the Trino Vercellese fuel assemblies is discussed in relation to the well-known inconvenience experienced with the reactor internals. Information is provided on the Garigliano fuel performance with an indication of the type and magnitude of observed faults, on the problem of crud buildup and remedial action taken. The main results of the Plutonium Recycle Demonstration Program under way at the Garigliano are described specifically as concerns irradiation of a mixed core containing prototype plutonium assemblies which have now reached a burnup of 7000 MWd/t. Development activities that have been carried out within CNEN Plutonium Program are reviewed. The most significant tests concern fuel designed and manufactured in Italy, which is being irradiated in Ågesta and Kahl reactors. Thermohydraulic parameters and vibration have been verified in out-of-pile tests. In the field of advanced reactors, activities for the CIRENE fuel and fast reactor fuel are described. Fuel elements for the 40 MW(e) CIRENE prototype reactor (BHWR type) are being irradiated in the Halden BWR, Avogadro, Essor CART loop and Ågesta reactor. Within the Fast Reactor Program, two types of in-pile experiments are being carried out to test fuel pins and subassemblies for the PEC reactor in the Dounreay and Rapsodie facilities up to burnups of 70,000 MWd/t; and to verify the feasibility of venting the fuel assembly directly to the coolant, in thermal reactors (Avogadro, Siloè) and in Dounreay fast reactors for burnups in the range of 20,000 to 100,000 MWd/t. The performance of small specimens of binary and tertiary uranium alloys irradiated up to a burnup of 6,000 MWd/t is also described. (13 references) (auth)

53890 (A/CONF.49/P-212) INTRODUCTION OF NUCLEAR ENERGY IN AUSTRIA: EXPERIENCES GAINED DURING TENDER EVALUATION INTERCONNECTION INTO THE AUSTRIAN GRID. Nentwich, A. A.; Staudinger, F.; Oszuszky, F. J. P.; Renner, W. May 1971. 11p. (CONF-710901-192). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The main considerations for introducing nuclear energy in Austria are discussed and the needs to secure high availability coupled with an optimum operational flexibility when introducing nuclear power into a hydropower orientated system are highlighted. The experiences gained during the evaluation period are analyzed. There are certain problems which turn out to be of great importance to the purchaser of a nuclear power plant, especially if this is going to be the first nuclear installation in a country. Economical problems encountered specifically with the fuel cycle are discussed in detail. This concerns mainly the recycling of plutonium in thermal reactors and the problem of securing long term uranium supply. Several studies are described which have been undertaken for selecting the optimum reactor site, preliminary in respect of the entire Austrian grid taking also into consideration the effects of being coupled to the vast European power transmission-system (UCPTE) and its economic influence on different sort of outages combined with the problem of keeping then adequate power to be interchanged at any time (reserve pool). Some ways for operational flexibility of a nuclear power station when introduced into a hydropower orientated system are described. (auth)

53891 (A/CONF.49/P-270) PROBLEM OF INTRODUCING NUCLEAR POWER IN A FAST GROWING ELECTRICAL ENERGY SYSTEM. Brellas, N.; Cassapoglou, C. B.; Margaritides, P.; (and others) (Public Power Corp., Athens, Greece). May 1971. 15p. (CONF-710901-102). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Greece is an example of a country with a relatively small electrical power system (present total installed capacity 2700 MW) which is growing very fast. The problem of the introduction of nuclear power to such a system is examined. The electrical energy situation of the country with the up to date existing power stations and demands is given as background information. The estimated future energy requirements both for the industry demands and other applications and needs are described to the year 2000. The known energy resources of the country for the operation of conventional power stations are also presented in relation with the problem of covering the present and future demands. The cost analysis of the conventional power stations is further reported together with a technoeconomical evaluation of various alternatives. The need for the introduction of nuclear power into the grid is discussed. A study concerning the size of the nuclear power plants in connection with the national and interconnected electrical system is given as well as the economical integration of nuclear power into the system. Domestic uranium deposits are also taken into account. An attempt is made to establish a time schedule scale for the introduction of various reactor types (Thermal-Converter-Breeder) into the system. (12 references) (auth)

53892 (A/CONF.49/P-278) IN-CORE FUEL MANAGEMENT IN PWR PLANTS. A PRACTICAL APPROACH. Melice, M.; Hunin, C. (Electrobel, Brussels (Belgium)); Vielvoye, A. (Societe de Traction et d'Electricite, Brussels (Belgium)). Jun 1971. 24p. (CONF-710901-371). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Two main problems form the basis of core management in a PWR: (1) The follow-up and the simulation of the core in order to know its safety margins during the cycle and to predict its condition at the cycle end, for fuel management calculations. (2) Management of core cycles: optimization at the successive cycles of the number and enrichment of fresh assemblies ("external" optimization) as well as the configuration ("internal" optimization) of the core reloading pattern. Codes of the CMDBE series are being worked out which are diffusion-evolution programs with 2 neutron groups. Internal optimization is done through the OMEGA code using iteratively a routine of linearization of the problem and a routine of optimization of the linearized problem. External optimization uses DBE1 and DBE2. It is performed in 2 steps: optimization of the equilibrium cycle and optimization of the return or attainment of equilibrium. (22 references) (auth)

53893 (A/CONF.49/P-294) ADVANCES IN CONTROL AND SUPERVISION OF POWER REACTOR PLANTS USING ON-LINE COMPUTERS, BASED ON EXPERIENCE FROM HBWR EXPERIMENTS AND OPERATION. Lunde, J. E.; Grumbach, R.; Oevreeide, M. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). May 1971. 20p. (CONF-710901-263). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The OECD Halden Reactor Project has since 1967 conducted a research and development program on the application of advanced methods for control and supervision of nuclear power plants, implemented with extensive usage of on-line computers. The feasibility of such methods is tested on the Halden Boiling Heavy Water Reactor (HBWR), which is a 25 MW(t) experimental reactor. The objective of the development work is to demonstrate that improved plant reliability and reduced downtime, as well as improved core performance and fuel utilization can be achieved for large nuclear stations when using advanced supervision and control approaches. The application of large process computer systems has been adopted for functions like supervision of process variables, data collection and reporting, and direct digital control of nuclear power, including power ramps, and of other variables. Emphasis has also been placed on computer-based operator and process communication, using consoles and displays. (16 references) (auth)

53894 (A/CONF.49/P-322) INTEGRATION OF NUCLEAR AND CONVENTIONAL HEATING POWER STATIONS IN DISTRICT HEATING SYSTEMS AND IN ELECTRIC GRIDS. Levai, A. (Technical Univ., Budapest, Hungary). May 1971. 16p. (CONF-710901-108). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Economics and safety aspects concerning the use of nuclear reactors for power generation and space heating applications are discussed. (7 references) (D.C.C.)

53895 (A/CONF.49/P-347) PROJECTION OF A LONG-TERM DEVELOPMENT OF NUCLEAR POWER IN YUGOSLAVIA.

Salom-Suica, J. (Yugoslav Nuclear Energy Commission, Belgrade). May 1971. 24p. (In French). (CONF-710901-486). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The paper summarizes a number of studies of the past development of power in Yugoslavia which all consider the main factors that determined the structure and the growth of power. It provides long-term projections of the generation and consumption of electric energy by the use of several methods of forecasts and optimization. Conclusions have been drawn as to the conditions of competitiveness of nuclear power stations and the possibilities of their integration into the country's power system. The analyses deal with the problem of the choice of reactor concept, the feasibility of different reactor strategies from the point of view of economics, the use of domestic nuclear raw materials and the conditions for an optimal employment of the national scientific, technical and industrial potentials in the implementation of a long-term nuclear program. The paper deals in particular with the analysis of the competitive determination of the optimal structure of power stations for the supply of the consumers in the system of the western part of Yugoslavia. The analysis will be conducted by the method of selecting optimal plants taking into account the needs of power and energy, the oscillation of hydro power plant productibility, the need to secure spinning reserve capacities and the time necessary for the usual overhaul of the units, and also the necessary allowances for plant black-outs. (12 references) (auth)

53896 (A/CONF.49/P-417) PLANNING AND CONTROL INVOLVED IN THE GOVERNMENTAL PROMOTION OF NUCLEAR ENERGY PROGRAMMES. Schuster, G.; Rembser, J. (Bundesministerium fuer Bildung und Wissenschaft, Bonn (West Germany)). May 1971. 27p. (CONF-710901-146). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In the Federal Republic of Germany, governmental promotion in the field of nuclear energy is primarily given to advanced sectors of nuclear technology; near-industrial development is carried out by private industry. The development of nuclear technology is carried on in governmental nuclear research establishments and by industrial companies. The emphasis in governmental activities is placed mainly on tasks of planning and control. (auth)

53897 (A/CONF.49/P-418) IMPORTANCE OF NUCLEAR TECHNOLOGY FOR THE DEVELOPING NATIONS. Boettcher, A. (Kernforschungsanlage, Juelich (West Germany)). Apr 1971. 6p. (CONF-710901-147). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The necessity of nuclear energy production is distinctly imposed on all countries. For developing countries requirements starting at the latest by the end of this decade with a following very rapid increase are to be expected, because of the generally very short doubling time of energy needs (6 to 7 years) and the relative shortage, respectively geographically unfavorable location of conventional energy sources. Scarcity of foreign exchange stimulates the rapid growth of self-supply of the nuclear fuel cycle and a growing participation in the setting up at least of the conventional parts of nuclear power plants. The relatively high demands as to precision and liability of production form an important stimulation for establishing industrial control and development laboratories. Nuclear science and technology are moreover suitable starting points for promoting scientific education as they need advanced experimental techniques and careful theoretical evaluation, giving at the same time new impetus to other faculties owing to the manifold applicability of nuclear methods. Nuclear technology stimulates the necessary cooperation of research institutes and industry and the integration as well of national efforts into international development. (auth)

53898 (A/CONF.49/P-460) DEVELOPMENT OF FUEL ELEMENTS FOR BOR-60 REACTOR. Leipunskii, A. I.; Zaimovskii, A. S.; Kasachkovskii, O. D.; Golovin, I. S.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 33p. (CONF-710901-388). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Presented are data on deformation property of steel, used for fuel element claddings, and on mechanical effect of swelling fuel core on the fuel element cladding. The calculated fuel element model with due regard for evolution of the core shape depending on fuel burn-up is presented. Given are descriptions of fuel element design, fuel element fabrication technology and fuel element working conditions in the reactor. Calculation results on fuel element working ability are presented. The experimental data on UO_2 and OX16H15M3 steel characteristics, stated in a number of Soviet and foreign works are used for calculations. Some general problems of oxide core fuel elements design for the fast power reactors are discussed. (12 references) (auth)

53899 (A/CONF.49/P-467) NUCLEAR POWER IN THE UNITED KINGDOM. Hill, John (United Kingdom Atomic Energy Authority). Jun 1971. 13p. (CONF-710901-473). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The changes that have taken place and the progress that has been made since the last Geneva Conference in 1964 are discussed. It considers the changing attitudes of industry to the problems of an advanced technology not only in the United Kingdom, but in many countries. The operating experience of the eleven nuclear power stations now in operation in the U.K. is discussed in detail. The six large nuclear stations now under construction are compared with the stations that preceded them. (16 references) (auth)

53900 (A/CONF.49/P-469) DESIGN AND PERFORMANCE OF HEAVY PLANT COMPONENTS FOR GAS-COOLED REACTORS. Southwood, J. R. M. (Nuclear Power Group Ltd., Knutsford (England)). May 1971. 12p. (CONF-710901-210). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Gas cooled reactor construction has required novel solutions to the engineering of components such as pressure vessels, boilers and circulators. Not only have the duties of these components been unusual but there has also been a demand for access for inspection and maintenance in an active environment. The U.K. Mk I Gas Cooled Reactor (Magnox) program, which is now complete, has provided a number of alternative solutions to these problems. As some of these reactors have now been in operation for several years, the relative success of different solutions can be judged from the experience gained. Various design features are described. The operational experience is reviewed to illustrate the success of these features. In particular, the design and construction of concrete pressure vessels and the problems encountered with the steel liners and internal insulation for these vessels are discussed. Reference is made to the success in achieving inspection and maintenance in areas which were originally considered inaccessible. The U.K. has followed the first Mk I G.C.R. program with plans for the installation of a number of Mk II Gas Cooled Reactors (A.G.R.s) with a capacity of at least 8,000 MW. Three such stations, each with twin reactors, are in an advanced stage of construction. Construction of a fourth station was started in 1968. The design features of the heavy internal components in these reactors reflect the experience gained during the Mk I G.C.R. program. Changes in design philosophies are described. The adoption of the concrete pressure vessel led immediately to a greater integration of the primary circuit components. This has in turn led to the use of a podded boiler construction on a recent station which permits the use of more readily removable boiler units. (7 references) (auth)

53901 (A/CONF.49/P-470) HANDLING OF FUEL AND REACTOR COMPONENTS IN GAS COOLED REACTORS. Lawson, D. S.; Slack, M. R.; Walker, A. (British Nuclear Design and Construction Co. Ltd., Leicester, Eng.). May 1971. 12p. (CONF-710901-283). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The design objectives in pursuing on-load refueling methods for the U.K. gas cooled reactors are illustrated by brief descriptions of typical fueling routes for Mk I Gas Cooled Reactors (Magnox). Two types of fuel handling emerge. The first uses two machines, one for preparing the route for fueling and the other for handling fuel; whereas the second has one composite machine for all functions. The fueling equipment at Hinkley Point "A" is used as an example of the former, with Sizewell "A" and Wylfa as developments of this; and that at Trawsfynydd as an example of the latter. A summary of the operating performance is given. The major problems that arose in design, development and at site are described together with their solutions. The experience gained from the successful development of refueling methods on the Mk I G.C.R.s has been applied to the development of simple refueling systems for Mk II Gas Cooled Reactors (A.G.R.s). The fueling philosophy that has emerged, together with its benefits, are seen in the design development for the Windscale A.G.R. and in the designs for Hartlepool and Heysham. (6 references) (auth)

53902 (A/CONF.49/P-478) INTEGRATION OF NUCLEAR PLANT INTO THE COMBINED HYDRO/THERMAL SYSTEM IN SCOTLAND. Barclay, R. S. (South of Scotland Electricity Board, Glasgow); Cochran, A. M. (North of Scotland Hydro-

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Electric Board, Edinburgh). Jun 1971. 11p. (CONF-710901-287). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The introduction of nuclear plant into an existing electricity supply system requires consideration from both economic and operational aspects. Problems of integration vary with the proportion of different types of plants, which can range from all thermal to all hydro electric and may include existing nuclear and pumped storage. At present in Scotland electricity generated from nuclear plant forms about $\frac{1}{6}$th of the total. Nuclear plant accounts for 8% of generating capacity. Hydro and pumped storage form 25% of generating capacity. Operational arrangements are described and the transmission network outlined. This system, formerly consisted of hydro electric and coal fired plants and has been developed by the introduction of nuclear, pumped storage, oil fired plant, and some gas turbine plant for peak load use. Operational experience, including the performance of existing nuclear plant, is reviewed. The current development program of new generating plants is outlined with the economic and operational considerations leading to the choice of each main project. The connection with load development is considered. When the nuclear and pumped storage plants now under construction are commissioned the proportion of each on the system will be nuclear 18%, hydro and pumped storage 19%. Operational procedures being prepared to meet these conditions are described. Looking to the long term development the prospects for inclusion of further nuclear, pumped storage and other types of plant are reviewed taking account of the operational considerations and trends of costs. (4 references) (auth)

53903 (A/CONF.49/P-500) PERFORMANCE OF THE FUEL ELEMENTS IN THE MK I GAS COOLED (MAGNOX) REACTORS OF THE CENTRAL ELECTRICITY GENERATING BOARD. Harris, J. E.; Duckworth, F. C.; Hines, G. F.; Uglow, A. G. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). May 1971. 13p. (CONF-710901-221). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Twelve of the sixteen C.E.G.B. Mk I Gas Cooled Reactors (Magnox) have now reached the end of the lifetime of the first charge and an equilibrium fuel cycle has been established. Operational experience relates to 75 reactor years (1.5×10^6 fuel element years) and the performance of the fuel has been assessed by post-irradiation examination of more than 4,500 selected fuel elements. A critical review of the results of this fuel element monitoring program is presented. The monitoring data have enabled recommendations to be made for the equilibrium reject irradiation to be raised progressively to the present level of 3,600 MWd/t channel average. Additionally, on an experimental scale, channels have been taken to 4,600 MWd/t average irradiation without any failure occurring. Contrary to earlier expectations, the magnesium cladding is not significantly embrittled by irradiation and the load-bearing magnesium components have adequate creep strength to withstand much longer residence times. At the lower operating temperatures, the fine grained cladding has sufficient ductility to accommodate the low strains induced from irradiation growth in the fuel. It appears that, while there has been no failure due to this cause, the occurrence of breakaway swelling in the most highly rated fuel is likely to prove life-limiting if considerable increases in target irradiation are adopted. Although the fuel element failure rate has been small, averaging about 0.07% per fuel element year, the associated post irradiation examination studies have been invaluable in identifying the reason for failure and in defining the hazards they present in the period prior to discharge. (27 references) (auth)

53904 (A/CONF.49/P-532) INTEGRATED PLANNING OF NUCLEAR INDUSTRY. Sethna, H. N.; Fareeduddin, S.; Meckoni, V. N.; Srinivasan, N.; (and others) (Bhabha Atomic Research Centre, Bombay (India)). May 1971. 17p. (CONF-710901-234). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

It has been proposed by the Indian Atomic Energy Commission that a total of 2.7 million KW of nuclear generating capacity would be installed by 1980. The program has been further planned such that the nuclear generating capacity doubles every five years so that it can contribute significantly to the total energy needs of the country. The program of construction of power reactors in the first and subsequent phases as well as the possible fuel cycles that could be adopted are presented. Based on this program, the nuclear industry, particularly with reference to the anticipated demand for and supply of uranium, plutonium, and heavy water as well as fuel fabrication and reprocessing services, is discussed. (auth)

53905 (A/CONF.49/P-571) PRESTRESSED CONCRETE PRESSURE VESSELS AND THEIR THERMAL INSULATION. Bordet, R.; Costaz, J. L.; Lida, M. (Electricite de France, Clamart). Jun 1971. 21p. (CONF-710901-397). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The characteristics of the Bugey-I pressure vessel are described. Operation measurements on the linings of Chinon III and St. Laurent II pressure vessels are given and interpreted. Prestressing of St. Laurent II and Bugey I pressure vessels is analyzed. Research and development programs on prestressed concrete pressure vessels are reviewed. (6 references) (J.M.J.)

53906 (A/CONF.49/P-584) PHENIX: FIRST FRENCH FAST NEUTRONS POWER PLANT. Carle, R.; Negy, J. (Commissariat a l'Energie Atomique, Paris (France)); Crette, J. P.; (and others) (Groupement Atomique Alsacienne Atlantique, le Plessis-Robinson (France)). Apr 1971. 15p. (In French). (CONF-710901-248). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The main options which prevailed during the design phase and the construction of the PHENIX 250 MW(e) fast power plant are described. The difficulties experienced in the design phase and the corresponding modifications are shown in detail: main vessel temperature, primary sodium flow pattern, and post-shutdown reactor cooling. The main components: control-rod driving gear, fuel handling mechanisms, steam generator, etc., have undergone full-scale tests, most of them in sodium. The results of these tests are shown. The difficulties encountered during the plant components construction or assembling are briefly listed. The plant testing sequence is presented. This testing period will cover about one year due to the prototype nature of the plant. (8 references) (auth)

53907 (A/CONF.49/P-676) SWISS PUBLIC OPINION AND NUCLEAR ENERGY. Feuz, P. (Swiss Association for Atomic Energy, Bern); Meichle, A. (Bernische Kraftwerke AG, Bern (Switzerland)); Winkler, W. (Bern Univ. (Switzerland)). Jun 1971. 14p. (CONF-710901-411). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Swiss public greeted the construction of the first nuclear power stations of Beznau and Mühleberg as a modern supplement to the practically exhausted hydro-electric sources and as a welcome alternative to the oilfired power stations, which it was feared would cause air and water pollution. Since the end of the 1950s the Swiss Association for Atomic Energy (SVA) had carried on a systematic public information program with various means and at various levels in order to prepare the introduction of nuclear energy. For a long time it seemed that these efforts had been entirely successful. However, in connection with the Kaiseraugst project there appeared for the first time a significant opposition which at first seemed to be restricted to a local scale, but which has since spread very rapidly to wider sections of the population. It is attempted to analyze the complex reasons for this opposition—which range from politics to serious concern over danger to the environment and to philosophical + ideological causes—and to classify the active opponents into groups. In addition the most important arguments used by the opponents are summarized both as to subject matter and according to their origin. (auth)

53908 (A/CONF.49/P-705) RADIATION RESISTANCE INVESTIGATIONS OF 48 TC HIGH-STRENGTH STEEL FOR REACTOR HIGH-PRESSURE VESSELS OF ATOMIC POWER STATIONS. Amaev, A. D.; Gorynin, I. V.; Efimov, A. V.; Kapyrin, G. I.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 26p. (CONF-710901-481). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The radiation resistance of 48TC steel (the basic metal and the metal of welded joints) was investigated after irradiation under different conditions. Special attention was given to the effect on increased embrittlement of dose and temperature of irradiation. The neutron radiation effect on material resistance to brittle rupture is estimated by different methods. Simultaneously, inpile radiation effects on steel under mechanical stresses was studied. The radiation resistance of 48TC steel is given in comparison with the radiation resistance of other steels. Estimates of reactor vessel reliability are given in relation to the design temperature margin of ductility. (11 references) (auth)

53909 (A/CONF.49/P-715) LENINGRAD ATOMIC POWER STATION AND PROSPECTS FOR CHANNEL BOILING REACTORS. Petrosyants, A. M.; Aleksandrov, A. P.; Bulkin, Yu. M.;

Dollezhal, N. A.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 38p. (CONF-710901-419). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The technical and economic parameters of the Leningrad Atomic Power Station are described. The station includes twin 1000 MW(e) boiling water-cooled graphite-moderated reactors with nuclear superheat. The potential of this type reactor as a converter when fueled with both enriched and natural uranium is examined. (8 references) (H.D.R.)

53910 (A/CONF.49/P-718) PROBLEM OF THE INTEGRATION OF NUCLEAR PLANTS INTO THE ELECTRICITY SUPPLY SYSTEM. Dollezhal, N. A.; Beschinsky, A. A.; Baturov, B. B.; Bacanov, A. V.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, [Moscow]). Jun 1971. 16p. (CONF-710901-363). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The limits of nuclear power plant development are analyzed from the economic and technical viewpoint as a function of time. The role of thermal and fast reactors in nuclear power plant development is studied. The influence of nuclear power plants on general development of power systems is discussed. Optimum operating conditions and types of nuclear power plants are analyzed for power systems. (auth)

53911 (A/CONF.49/P-729) NUCLEAR ENERGY IN THE SPANISH ELECTRIC SYSTEM. Pascual, F.; Palacios, L. (Junta de Energia Nuclear, Madrid (Spain)); Ortega, J.; Gaitan, I. (Junta de Energia Nuclear, Madrid (Spain). Direccion General de la Energia y Combustibles). May 1971. 15p. (In Spanish). (CONF-710901-501). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Spanish electric system includes currently two nuclear units in operation and one more under advanced construction. The experience obtained thus far enables planners to program the economic integration of nuclear power plants into the Spanish grid over the near future. It is estimated that 71,000 MW of nuclear plant will be installed by the year 2000, accounting for 60.7% of the total installed power. Light water reactors are expected to be the main contributors, with fast breeders being progressively introduced. (auth)

53912 (A/CONF.49/P-757) NUCLEAR REACTORS IN LATIN AMERICA. Velez, C. (Inter-American Nuclear Energy Commission, Washington, D. C.). May 1971. 13p. (In Spanish). (CONF-710901-509). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

53913 (A/CONF.49/P-778) PROJECTED ROLE OF NUCLEAR POWER IN KOREA. Lee, Y. J. (Atomic Energy Research Inst., [Seoul (South Korea)]. Jun 1971. 8p. (CONF-710901-427). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

53914 (A/CONF.49/P-780) GROWTH OF DEMAND FOR ENERGY AND PROJECTED ROLE OF NUCLEAR POWER IN TURKEY. Aybers, N. (Technical Univ. of Istanbul); Kakac, S. (Middle East Technical Univ., Ankara, (Turkey)). May 1971. 26p. (CONF-710901-328). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Existing power system, energy requirements up to year 2000, and power development in Turkey are reviewed. Available conventional energy resources such as fossil fuels and hydropotential for meeting long term energy requirements are considered. From the estimated costs, the competitiveness of nuclear power and the influence of local conditions on capital cost are discussed. It is shown that, in view of the limited amount of fossil fuel in Turkey, nuclear power would be very promising source of electricity for sustaining and accelerating the country's economic development. Projected role of nuclear energy is expected to play in meeting near-term energy requirements for electric power and desalination is also summarized. 10 references. (auth)

53915 (A/CONF.49/P-788) DEFINITION OF A POWER REACTOR PROGRAM FOR MEXICO. Velez, C. (Comision Nacional de Energia Nuclear, Mexico City). Jun 1971. 13p. (CONF-710901-330). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In order to define a program for technology assimilation and development, it was necessary to consider the possible reactor evolution in the world and the prospects for their utilization in Mexico. With this purpose, probabilities were assigned to the use of different reactor types in Mexico, including fusion reactors, at several dates up to year 2000. It was thus possible to construct an ensemble of "futures" and to assign relative weights to development plans within a comprehensive policy, taking into consideration in as much as possible the economic aspects of associated costs and benefits. (auth)

53916 (A/CONF.49/P-793) NUCLEAR ENERGY IN MEXICO'S ECONOMIC DEVELOPMENT. Galvez, L.; Trevino, R. (Comision Nazional de Energia Nuclear, Mexico City). Jun 1971. 13p. (CONF-710901-332). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The history of nuclear energy activities in Mexico is reviewed. Recommendations for a federal program to encourage the development of nuclear energy applications are presented. (H.D.R.)

53917 (A/CONF.49/P-798) THERMAL ENERGY STORAGE IN ROCK CHAMBERS. A Complement to Nuclear Power. Margen, P. H. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Jun 1971. 17p. (CONF-710901-429). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Studies have been made of storing hot high pressure water in rock cavities with a simple thermal insulation. One method of utilizing this water is as feed water for a nuclear power station, the water in the store being heated from about 73°C to 217°C at night, and the stored hot water being fed directly to the Nuclear Steam Supply System (NSSS) during the day. An increase in turbine output by about 25% can then be achieved at peak periods due to the elimination of the h.p. steam bleeding for unchanged reactor power. About 35 kWh of electricity can be recovered per m^3 of storage volume, i.e. 30 times as much as if one m^3 of cold water had been allowed to descend 450 m under gravity to the lower magazine of a pumped storage plant. The circuit proposed and the design of the accumulator to meet the requirements concerning thermal insulation (to avoid exposing the rock walls to daily temperature cycles), avoidance of risk of leakage of slightly active feed water to the surrounding ground water even under severe accident conditions such as pipe and tank ruptures, and water chemistry to avoid water containing impurities or dissolved gases from reaching the feed water circuit is described. A preliminary cost analysis is given which shows that the proposal allows the generation of additional blocks of peak load power at annual load factors of 15 to 40% at generation costs which are about half that of the best fossil fuel plants at typical fossil fuel costs. 6 references. (auth)

53918 (A/CONF.49/P-811) REPAIR AND RESTORATION TO POWER OF SAINT-LAURENT 1 AFTER AN INCIDENT OF FUEL MELTING. Knockaert, A.; Teste du Bailler, A. (Electricite de France, Saint-Laurent-des-Eaux). Jun 1971. 16p. (CONF-710901-433). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

An incident which occurred on October 17th, 1969, in the Saint-Laurent 1 reactor, and of the following recovery actions and start up of the reactor is described. This natural uranium, gas, graphite reactor, nominal output 480 MWe, was started up on March 1969 and the first six months of operation were very satisfying from all points of view. On October 19th, 1969, following an erroneous handling procedure, a graphite block with a restricted flow passage was loaded in one of the channels. This resulted in the meltdown of five of the fifteen fuel elements of the channel and the dispersion of the uranium in the reactor vessel. The repairs have included a debris recovery, mostly performed by direct access of 105 workers, on a time limit basis, close to the reactor core, and the erection of a total filtration equipment for the carbon dioxide circuit inside the pressure vessel. Also the burst cartridge detection system has been modified, as well as the fuel handling procedures. The reactor has been reconnected to the grid on October 16th, 1970, and has reached in November a power of 430 MWe. 15 references. (auth)

53919 (JPRS-53800, pp 252-7) INVESTIGATION OF FUEL ELEMENT ASSEMBLY IN THE VK-50 BOILING REACTOR. Andreev, A. B.; Belokopytov, V. S.; Votinov, S. N.; Derebizov, M. D.; Petin, B. P.; Pakhomov, Z. I. Translated from pp 252-7 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

Results are presented of materials research studies of fuel element assemblies used up to 5000 hr in the VK-50 core. The fuel element cores are UO_2, and the shell material is Zr-1% Nb alloy. An assembly with detected gas radioactivity was examined. Microstructures of the shells of defective and nondefective fuel

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elements were examined for hydride phase, and their strength and plastic properties were determined. The results indicate a good stability of the Zr−1% Nb alloy and satisfactory fuel element efficiency. (D.L.C.)

53920 (TID-8200(24th Rev.)) NUCLEAR REACTORS BUILT, BEING BUILT, OR PLANNED IN THE UNITED STATES AS OF JUNE 30, 1971. (Office of the Assistant General Manager for Reactors (AEC), Washington, D. C.). 37p.

Data on U. S. facilities capable of sustaining a nuclear chain reaction are tabulated. The reactors and critical assemblies are categorized by primary function, and statistics tabulated include name, owner, location, principal contractor, type, power, startup date, and shutdown date. (D.C.C.)

53921 (TID-25602) PUERTO RICO ENERGY CENTER STUDY. EXECUTIVE SUMMARY. (Burns and Roe, Inc., New York. Dow Chemical Co., Midland, Mich.). Jul 1970. 71p. Dep. NTIS.

Economic aspects of constructing and operating an agro-industrial complex in Puerto Rico are presented. Design parameters of the Aguirre Power Reactor Unit 1 are described. (D.C.C.)

53922 (TID-25603(Vol.1)) PUERTO RICO ENERGY CENTER STUDY. VOLUME I. (Burns and Roe, Inc., New York. Dow Chemical Co., Midland, Mich.). Jul 1970. 267p. Dep. NTIS.

Economic aspects of constructing and operating an agro-industrial complex in Puerto Rico are presented. Design parameters of the Aguirre Power Reactor Unit 1 are described. Industrial applications are analyzed. (D.C.C.)

53923 NUCLEAR POWER AND THE ENVIRONMENT. Proceedings of a Student Conference, Held at Madison, Wisconsin, April 3–4, 1970. Madison, Wis.; University of Wisconsin (1970). 232p. (CONF-700415).

Separate abstracts were prepared for the eleven papers presented. (D.H.M.)

For abstracts of individual papers see: 51590, 52013, 52104, 52235, 54003–54007, 54048, and 54165.

53924 NUCLEAR POWER PLANTS AS TECHNOLOGICAL AND PHYSICAL SYSTEMS. Rambusch, K. (VEB Kombinat Kraftwerksanlagenbau, Berlin); Meyer, K.; Gruellich, G. (Kernenergie; 13: 305-9(Oct 1970). (In German).

Following a brief discussion of nuclear power plant development in the capitalistic countries, the situation in East Germany is described. Industry is permitted only to construct and to operate nuclear facilities but not to carry out research and development. Therefore, this aspect must be performed by German universities in close cooperation with their Russian counterparts. Two new fields are described: reactor physics and health physics. Reactor physics mainly establishes computer programs for calculations of reactor behavior. Because of such computations, the testing time for new reactors can be accelerated. 12 references. (H.B.G.)

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Refer also to abstracts 54133 and 54244.

53925 (70-CNA-617) STATUS OF THE DOUGLAS POINT PROJECT. Siddall, E. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 1970. 6p. (CONF-700564-18). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

53926 (A/CONF.49/P-8) NUCLEAR POWER PLANT RELIABILITY AS A FACTOR INFLUENCING THE POWER SYSTEM PLANNING IN FINLAND. Viheriaevaara, H.; Ervamaa, J. (Atomic Energy Commission, Helsinki (Finland)). May 1971. 22p. (CONF-710901-63). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The relation between the size and reliability of large power plants and the power system dimensioning is discussed with the aid of risk of consumption restriction. A reliability analysis is performed for nuclear power plants on the basis of functional schemes. The nuclear power plant reliability is described by a probability distribution, which is calculated with the aid of the operation experiences from the main components. Calculation methods for the reliability estimation of power systems as well as nuclear power plants are presented. (auth)

53927 (A/CONF.49/P-21) INTEGRATION OF NUCLEAR POWER IN AN ELECTRICITY PRODUCTION SYSTEM WITH AN INTERCONNECTING TRANSMISSION NETWORK. Clason, R. J. (Samenwerkende Electriciteits-Productiebedrijven, N. V., Arnhem (Netherlands)); Rienstra, F.; Wiechers, W. K. (Keuring van Electrotechnische Materialen, N. V., Arnhem (Netherlands)). May 1971. 19p. (CONF-710901-71). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The introduction of nuclear power and other power production facilities, such as gas turbines, with completely different cost characteristics compared with conventional thermal units, emphasizes the need to determine the optimum combination of different types of production facilities in an electricity supply system. This should be determined by calculating the optimum way of expanding an existing system over a number of years, possibly by taking future developments into account. Calculations presented show that, with present day expansion rates of electricity systems, the need to look far ahead in determining the optimum expansion scheme is not very great. Furthermore there seems to be a large number of alternatives leading to very different compositions of the expanded system with only small cost differences. This result is to a large extent caused by the fact that the economic benefits of nuclear units are partly offset by less favorable load-factors for the other units in the system. (auth)

53928 (A/CONF.49/P-148) COMMISSIONING AND OPERATING EXPERIENCE WITH CANADIAN NUCLEAR-ELECTRIC STATIONS. Woodhead, L. W. (Hydro-Electric Power Commission of Ontario, Toronto); Milley, D. C. (Hydro-Electric Power Commission of Ontario, Rolphton); Elston, K. E. (Hydro-Electric Power Commission of Ontario, Tiverton); Horton, E. P. (Hydro-Electric Power Commission of Ontario, Pickering); (and others). May 1971. 19p. (CONF-710901-167). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Fourteen Canadian-designed nuclear-electric generating units are operating or under construction, with a total capacity of more than 6000 megawatts. NPD has operated reliably for nine years both as an energy producer and as a facility for training and technical development. An average capacity factor of 96% was achieved in five successive winters. In 1968 the NPD heat-transport system was converted from pressurized heavy water to boiling heavy water. During the four years of operating experience at Douglas Point, data have been collected on heavy-water upkeep, heat-transport chemistry, radiation fields, performance of mechanical components (pumps, valves, turbine) and the main causes of lost production. Gentilly, the first CANDU reactor with a direct-cycle heat-transport system (boiling light water), went critical on 12 November 1970. Low-power reactivity characteristics and early experience at high power, particularly transient behavior, are described. Discussion of Pickering and KANUPP concentrates on the experience obtained during commissioning, particularly the containment system operating under negative pressure at Pickering, and the initial operating experience. At both NPD and Douglas Point, severe failures of pumps in the heat-transport systems have been experienced. Corrective action has, however, been very effective. On-power refuelling has been routine at NPD since November 1963 and at Douglas Point since March 1970. In November 1969 improved "Mark II" fuelling machines were installed at NPD and resulted in easier maintenance and greatly improved reliability. Heavy-water management has continued to receive priority attention. Experience with mechanical equipment, containment methods and recovery equipment at NPD and Douglas Point has provided the information on which to base improved systems for Pickering and Bruce. 4 references. (auth)

53929 (A/CONF.49/P-149) COSTING OF CANADIAN NUCLEAR POWER PLANTS. Bate, D. L. S.; Mayes, P. F.; Philip, W. S. (Atomic Energy of Canada Ltd., Sheridan Park (Ontario)). May 1971. 15p. (CONF-710901-168). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Techniques have been developed for estimating the costs of nuclear power plants and for recording and monitoring the actual expenditures. Comparative costs of stations under construction in Ontario show that nuclear power is competitive. Cost reduction programs are being implemented, but their results are not always apparent because of inflation and the rise in interest rates. Although nuclear still offers a lower unit energy cost when stations are operated at a high capacity factor, the economic climate, together with a desire for peaking plant capacity, is leading to a mix of fuels (fossil and nuclear) in the Ontario network. Foreign-exchange requirement is a factor for most countries to consider before committing construction of a nuclear power plant. In a developing country, the foreign exchange required for an imported

CANDU power station might run to 80% of the total direct equipment costs, although with a series of such stations—allowing opportunity for local industry to develop—this percentage could quickly drop. Even in Canada, a minimum of 20% of the equipment costs represents necessary imports. However, in Ontario, which has to rely largely on imported coal and oil, fuels for an equivalent fossil-fired plant would soon run up much larger foreign-exchange requirements. To reduce capital costs of CANDU reactors, emphasis needs to be placed not so much on design refinements as on indirect items: interest during construction, engineering, construction overheads. The control of cash flow is important, and a shortened construction period is vital. Beneficial effects will result as the reactor size and the manufacturing volume increase. Designing for better reliability will also help keep down unit energy costs. 10 references. (auth)

53930 (A/CONF.49/P–171) SPECIAL TECHNIQUES FOR INSPECTION, REPAIRS AND SURVEILLANCE OF ENEL NUCLEAR PLANTS. Cioli, F.; D'Anna, G.; Velona, F. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). May 1971. 13p. (CONF-710901–182). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The techniques adopted during plant shutdown to verify the actual conditions of the main components, particularly those affecting safety, are described. Since the radiation levels of these components is generally high, recourse to remote-inspection methods was necessary, which involved the use of a TV camera and borescope and the adaptation of common industrial techniques (ultrasonics, dyes, etc.). Some of the techniques adopted to perform special repair or modification work and the means to ascertain the adequacy of the repairs are discussed. Techniques that were developed recently to supervise the reactor operating conditions in order to detect the onset of abnormal conditions are described. One major example of these techniques is the noise analysis through signals from the ion chambers, accelerometers or other transducers installed in the primary circuit. 6 references. (auth)

53931 (A/CONF.49/P–172) OPERATING EXPERIENCE IN ITALIAN NUCLEAR POWER PLANTS. Angelini, Arnaldo M. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). May 1971. 16p. (CONF-710901–86). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Operating statistics are tabulated for the Latina, Garigliano, and Trino Vercellese nuclear power plants for 1963 to 1971. (H.D.R.)

53932 (A/CONF.49/P–300) LONG-TERM PLANNING FOR NUCLEAR POWER IN THE NORDIC COUNTRIES. Nevanlinna, L.; Stroemme, R.; Nordstroem, B.; Nordloef, G. (Swedish State Power Board, Stockholm). May 1971. 12p. (CONF-710901–264). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Between the Nordic countries there is a very close electricity supply cooperation taking place within Nordel which is the cooperation organization of the Nordic power companies. Several long-term studies have been carried out in the Nordic countries as to the future development of the consumption of electric energy. Studies have also been made of how to cover the increasing demand for energy in an optimum way. These studies have primarily concerned the period up to 1980 but outlooks have also been made towards 1985 and 1990. Nuclear power in the Nordel system is expected to rise to a share of about 20% of the production of electric energy up to 1980. The share of hydro power will then decrease to 50 to 60% whereas conventional thermal power will remain at some 25%. (auth)

53933 (A/CONF.49/P–301) OPERATING EXPERIENCE OF THE AGESTA NUCLEAR POWER PLANT. Sandstedt, K. E. (Swedish State Power Board, Stockholm); Mogard, H.; (and others) (Aktiebolaget Atomenergi, Studsvik (Sweden)). May 1971. 15p. (CONF-710901–199). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Agesta is a PHWR used for production of electricity (12 MW) and district heat (68 MW). The reactor achieved criticality in July 1963. Power operation began in March 1964. The reactor has been in operation for 31,000 hours up to and including October 1970. The availability figures for 1964 and 1965, 50 and 64.5 percent, are low because of the repair of a severe heavy water leak through some inspection pipes in the reactor vessel lid. In 1966 and 1967 high availability figures, 95.5 and 99.5 percent, were reached. Indications of fission gas release resulted in reactor shut down for inspection in March 1968. It was apparent that the core was severely damaged. All assemblies had to be unloaded for inspection. It appeared that some assemblies had lost their bottom cone and part of the shroud tube in the reactor. Fuel pin segments and shroud tube pieces had fallen to the bottom of the reactor. Some assemblies showed extensive shroud tube crackings, particularly spacer penetrations. An extensive cleanup operation had to be performed before the reactor could be put into operation again. About 1 kg of the fuel still remained in the reactor primary system, out of reach for a cleanup operation. The cause of the fuel failure was attributed to fretting corrosion, probably initiated by an unscheduled reactor power cycling during a shut-off period of the cooling tower. Availability 1968: 45 percent. In May 1969 a non-return valve in the recooler system broke and caused an extensive flood. Water reached a relay cubicle, where an earthing fault resulted in undesirable automatic operation of pumps and motor valves in emergency systems. Availability 1969: 97.7 percent. Up to and including 1969 the total non-collectable heavy water losses have been approximately 1100 kg. The collectable amount about 1600 kg. Total heavy water weight in the primary system: 73,000 kg. 13 references. (auth)

53934 (A/CONF.49/P–302) COMMISSIONING OF THE OSKARSHAMN NUCLEAR POWER STATION, UNIT NO. 1. Gimstedt, C.; Hilding, S. O.; Rydell, N.; Sandberg, O. (Oskarshamnsverkets Kraftgrupp A.B., Stockholm (Sweden)). May 1971. 17p. (CONF-710901–200). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Oskarshamn I is the first large scale nuclear power unit in Sweden. The utility assumes responsibility for the nuclear safety of the plant and for the conventional pressure system safety whereas the main contractor Asea–Atom has the technical responsibility for the start-up and trial operation of the plant. Preoperational inspection of the reactor vessel, training and organization of plant personnel, and nuclear licensing of the plant are described. The preoperational inspection was carried out with remotely controlled ultrasonic equipment. The programme for the inspection was settled before the new ASME code was published but conforms largely with it. Experience with the equipment and from the inspection are presented. Recruitment and training of plant operating personnel has required special attention, since Sweden has few thermal power plants and only one, fairly small, nuclear plant. The organization scheme and the training programme is presented, and also some considerations on a training center with a nuclear plant simulator for the increasing number of reactor operators which must be trained over the next 5 to 10 years. The approach to licensing of this plant, the first of its kind, for operation has been to proceed by steps. The problems with coordination of the final stages of installation work, of submission of final safety analysis documents, of carrying out and reporting of tests and measurements, and of coordination of the interests of the utility and of the contractor during the start-up activities are reviewed. 8 references. (auth)

53935 (A/CONF.49/P–303) OSKARSHAMN I: A SWEDISH 440 MW(e) BWR NUCLEAR PLANT. Pind, Christen (ASEA-ATOM, Vasteras (Sweden)). May 1971. 7p. (CONF-710901–265). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Experience from the construction and commissioning of the Oakarshamm I boiling water reactor plant is reviewed. Some features intended to improve plant availability and reliability are also described. Results are presented from the pre-critical test runs with major components and nuclear plant systems. The physical measurements during the loading of the reactor are reviewed. A review is also made of the plant system performance testing while bringing the plant to power. Correlations are made with the extensive predictive calculations made with codes for static and dynamic behavior respectively. 8 references. (auth)

53936 (A/CONF.49/P–338) ON THE FUNDAMENTAL ECONOMIC AND NATIONAL ENERGY BALANCE CONSIDERATIONS UNDERLYING THE FUTURE DEVELOPMENT OF THE NUCLEAR POWER INDUSTRY IN POLAND. Fiszer, Waclaw May 1971. 8p. (CONF-710901–276). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The competition of nuclear power plants in comparison with thermal ones with coal combustion are of course essential for the development of the nuclear power industry. A preliminary analysis indicates that at the stage of 1980, when the first nuclear power plant is to be started, such competition can only be afforded by power plants equipped with large power reactors assuring a high availability. Therefore, the application of pressurized water reactors (PWR) rated at 1000 MW(e) is foreseen for the first nuclear electric power plant. The 400 kV supergrid

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allows without difficulty the integration of blocks of this capacity. At the next stage, basing on the fuel cycle, a proportional development of electric power plants equipped with fast breeder reactors and thermal reactors should follow. (auth)

53937 (A/CONF.49/P-390) OPTIMIZED FUEL MANAGEMENT IN NUCLEAR POWER STATIONS. Schenk, H. Apr 1971. 16p. (CONF-710901-136). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The decision on the pattern of the fuel cycle to be followed must be taken about two years or more in advance of the loading. This can be done through the optimum selection of enrichment of the respective fuel loading and by long-term planning for those fuel elements which are to be used for standby purposes in between two refueling actions. The choice of the type and number of used fuel elements for standby purposes for one or two operating periods is significant in this context. The second category of possibilities of influencing the time of refueling so as to approach the optimum is offered by those steps which can be taken in the period between two years and half a year in advance of the respective refueling date, such as influencing through the load factor, the medium-term possibilities constituted by the proper choice of used standby fuel elements, and the best shuffling pattern, for instance, through the most advantageous choice of the fuel elements to be exchanged. The third category of parameters of influence determine the extent of short-term flexibility in adapting refueling to the requirements of the power grid. This can be achieved through an optimum choice of the quantities discharged, i.e., if necessary by way of a change at short notice of the number of fuel elements to be discharged or through the possibility of shortening or extending the target burnups of the respective core loading. Stretch-out operation may be rather important in optimization. (auth)

53938 (A/CONF.49/P-425) FUEL MANAGEMENT PROBLEMS IN THE SWEDISH POWER SYSTEM. Ahlstroem, P.-E.; Edman, R. (Swedish State Power Board, Stockholm); Almgren, B. (Oskarshamnsverkets Kraftgrupp A.B., Stockholm (Sweden)); Segerberg, F. (ASEA-ATOM, Vasteras (Sweden)). May 1971. 14p. (CONF-710901-279). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A transition from an almost pure (95%) hydroelectric power supply system to a mixed thermal (nuclear and fossil) and hydroelectric system will take place in Sweden in the 1970's. This will create some special fuel management problems in the light water reactors which are being and will be constructed to meet the increasing power demand during the next decade. Owing to the seasonal variation in the supply of water and the power demand there is a very strong incentive to refuel the reactors in July or at least during the three summer months (mid-June to mid-September). Metrological fluctuations from one year to another will cause a variation in the optimum load factor per year for nuclear power of about ±15%. Superimposed on these variations in demand the availability of any one nuclear generating unit will vary in an unpredictable way. The changes in energy production per year thus obtained for any LWR must be handled by a flexible fuel management scheme in order to avoid refuelling shut down during the unfavorable part of the year. Principles for the fuel management in this situation are discussed. It is pointed out that the long lead time for ordering of enriched uranium implies that short time variations cannot be met by varying the fuel enrichment. Another method is to keep spare fuel assemblies and to adjust the number of replaced assemblies in accordance with the energy production during the previous cycle. It will be shown that this method can be adapted to a BWR in a favorable way. In order to avoid power shortage due to lack of water or shut down of big plants the power system requires reserve capacity. An energy reserve can be secured either by using peak power stations e.g. gas-turbines or by the loading to a higher reactivity than otherwise planned for. An energy reserve special for nuclear power is the possibility to use stretch out i.e. extract more energy by reduction of the power. 3 references. (auth)

53939 (A/CONF.49/P-468) PERFORMANCE OF NUCLEAR POWER PLANTS. Rutter, R. L. (Central Electricity Generating Board, London (England)). May 1971. 12p. (CONF-710901-209). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The C.E.G.B. has operated nuclear power stations since 1962 and now has 76 reactor years of operating experience. About 11% of total generation is provided by nuclear power stations in the C.E.G.B. network. Despite the large installation few changes in organization have been found necessary, either at stations or elsewhere in the Board. Nuclear power station staffing is compared with that for a comparable modern conventional power station. Because of their low generating cost and high availability C.E.G.B. nuclear power stations are run at high load factors. Two technical matters are discussed. The first is concerned with the extension of the fuel element failure detection system to include delayed neutron sensing. The second is the discovery of steel oxidation at higher rates than were originally anticipated. The operational effects of the latter have been to limit gas outlet temperatures and to require very detailed inspection of the steel work affected. Output has been marginally reduced but availability remains high. (auth)

53940 (A/CONF.49/P-473) ECONOMIC ASSESSMENT OF NUCLEAR POWER PLANT. Gibbs, K. P. (Central Electricity Generating Board, London (England)); Carruthers, H. M.; (Associated Nuclear Service, London); Maybrey, A. (Kleinwort Benson Ltd., London). May 1971. 11p. (CONF-710901-212). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The ground rules which have been and are currently being used for the economic evaluation of nuclear power stations in the U. K. are reviewed. The effects of financing aspects in the U. K. and overseas are discussed. The basis for selecting amortization periods is considered together with the problem of forecasting lifetime load factors for new nuclear stations and their effects on the operating costs of the system as a whole. The relative importance of accuracy in the various assumptions is discussed. Examples of nuclear projects are then quoted, and the actual expenditure and its incidence compared with the assumptions used in the initial evaluations. 3 references. (auth)

53941 (A/CONF.49/P-474) SAFETY OF NUCLEAR POWER PLANTS. Dale, G. C.; Harrison, J. R. (General Electricity Generating Board, London (England)). May 1971. 11p. (CONF-710901-213). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The operation of the U.K. nuclear power stations is such that defined safety standards are adhered to. This requirement is related to operation under normal (non-fault) conditions, and to the unlikely condition of a significant plant fault which might lead to fission product release into the pressure circuit and subsequently to the atmosphere. The design of the stations must ensure that operation at the design power permits the safety standards to be maintained. Design standards are outlined with particular reference to the steel pressure vessels and to the development of the concrete vessels. The protection standards of independent parameter tripping with adequate redundancy are described and the development of later system designs given. The extent of surveillance necessary during construction to ensure that design standards are achieved is analyzed. The criterion for plant operation is that in the event of the maximum credible accident occurring, the probability of a fuel can temperature in the reactor greater than 640°C must not exceed 0.01. Operating conditions consistent with this standard are defined in Operating Rules. Plant maintenance is summarized in a Maintenance Schedule and the significance of this maintenance in ensuring satisfactory plant conditions is described. Appropriate limits on radioactive discharges during routine operation are placed on the Board by the authorizing Ministries. A review of the experience in this area is presented. Examples of unusual incidents which have occurred are given. 5 references. (auth)

53942 (A/CONF.49/P-479) POWER SYSTEM FLEXIBILITY REQUIREMENTS AND THEIR EFFECT ON THE DESIGN OF NUCLEAR REACTORS. Ashmole, P. H. (Central Electricity Generating Board, London (England)); Bulloch, R. S.; Tyrrell, J. F. (British Nuclear Design and Construction Ltd. [Whetstone (England)]); Perrin, A. J. (Babcock and Wilcox Ltd., London (England)). May 1971. 12p. (CONF-710901-149). Dep. NTIS (U. S Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

While nuclear power stations currently under construction in the U.K. will not be required to load cycle to a significant extent, future designs undoubtedly will have this duty. To examine the future operational requirements of nuclear plant it is necessary to evaluate the nature of system load variations in terms of size, frequency and rate of change. Such an evaluation has been carried out by analysis of the U.K. load characteristics over a number of years and is summarized. The suitability of the Mk II Gas Cooled Reactor (A.G.R.), the Mk III Gas Cooled Reactor (H.T.R.), the Steam Generating Heavy Water Reactor and the Fast Reactor in meeting this requirement is discussed. In general the daily part-load and grid frequency regulation duties could give rise to excessive thermal cycling of the fuel, reactor components, boilers and turbines. The conflicting constraints of these various components are discussed. By suitable adjustment of the control system set points a satisfactory compromise can be achieved in reducing the effects of thermal cycling. Although the demand for maximum emergency pick-up response is relatively infrequent, it does place a most onerous demand on the station control system to achieve a rapid and sustained change in power without, at the same time, creating disturbances which would lead to the plant tripping. The capabilities of the four reactor types are considered. (auth)

53943 (A/CONF.49/P–519) INTEGRATION OF NUCLEAR POWER STATIONS INTO A SMALL POWER SYSTEM WITH LARGE HYDRO CAPACITY. ECONOMICS OF IMPORTING ENERGY TO ALLOW THE SPACING OF NEW CAPACITY ADDITIONS. Sergio, R.; Amaro, A.; Honorio, L.; Redol, A.; (and others) (Junta de Energia Nucleare, Lisbon (Portugal)). May 1971. 18p. (CONF-710901–231). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A power system simulation model was built for the study of the nuclear power role in the long term expansion of the Portuguese system. A characteristic feature is the management of the hydro-storage capacity receiving natural in-flows and pumped energy in the presence of thermal power with proportional costs varying over a wide range. In the medium term, modest annual increases in energy requirements hinder the integration of nuclear power stations in economic sizes. Spacing new capacity additions creates the room for large stations. With an installed hydro capacity designed to accommodate flows typical of wet periods, the main risk to the security of supply is the occurrence of a dry year during the periods preceding the addition of a new nuclear station. The interconnection with the European system through Spain whose power capability is no longer strongly limited during dry periods opens the possibility of economically covering that risk. An interconnection is simulated by a power station with appropriate proportional costs whose availability is not considered during the high loads of the winter months. Some examples are shown where the costs of importing energy are compared with the savings of spacing new capacity additions. (auth)

53944 (A/CONF.49/P–526) PERFORMANCE OF THE TARAPUR ATOMIC POWER STATION. Dayal, M. (Department of Atomic Energy, [Bombay] (India)). Jun 1971. 17p. (CONF-710901–394). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Tarapur Power Station, India's first Atomic Power Station, uses sea water for condenser and auxiliary cooling. It consists of two boiling water reactors, each with associated turbo-generator unit. The unit capacity is 210 MW. In February 1969 both the reactors were critical. Power started flowing from April 1, 1969. A comprehensive program of tests of various plant systems including transient tests and power interruption tests was carried out. The Station started producing power on a regular basis from October 9, 1969. The startup test program, the performance of the plant during tests, and the performance after the plant turnover are described. Until the planned outages of the units during the monsoon of 1970 for the annual inspection/maintenance, the on-line availability of the two Units taken together was more than 90%. Various technical problems, and how they were resolved as they arose, are described. The behavior of the fuel and various parts of equipment, as well as the radiation and activity release are described. Survey of some of the primary system piping and inspection of the turbine done during the monsoon outage and certain special problems that were attended to are also described. (auth)

53945 (A/CONF.49/P–527) COSTING OF NUCLEAR POWER STATIONS IN INDIA AND RECENT COST TRENDS. Meckoni, V. N.; Rao, V. Surya (Department of Atomic Energy, [Bombay] (India)). Jun 1971. 8p. (CONF-710901–395). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Elements of cost, as applicable to four reactor units of generally the same design, but which are being built at two different locations in India under varying conditions, are presented. The experience gained towards maximizing import substitution by encouraging local industry to take up manufacture of specialized nuclear components is described. The general effect of escalation in cost on account of varying construction periods is brought out, and the sensitivity of the unit energy cost to future escalation in prices of coal and uranium is presented. (auth)

53946 (A/CONF.49/P–528) PLANNING FOR OPTIMUM PHASING AND ABSORPTION OF POWER PLANTS IN GRIDS. Parikh, K. S.; Shiralkar, S. S. (Department of Atomic Energy, Bombay (India)); Seshagiri, N.; Mehndiratta, S. L.; (and others) (Tata Inst. of Fundamental Research, Bombay (India)). May 1971. 22p. (CONF-710901–232). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The introduction of a nuclear power plant in a system is dependent on the total size of the electrical system and also on the expected growth of the system. A multi-regional inter-temporal programming model is developed to investigate the question of optimal timing. The model permits in each time period in each region the choice of either a coal-based thermal plant or any one of different types of nuclear power plants. The objective is to minimize the present discounted cost of meeting the requirements of power. The interactions of the fuel cycle and the need to build up fuel inventory for breeder reactors are also taken into account. To demonstrate the applicability of the model, a plan for power development for India for the next thirty years is prepared. (auth)

53947 (A/CONF.49/P–542) PHYSICAL EXPERIMENTS INVOLVED IN THE PROGRAM OF THE START-UP OF THE FIRST CZECHOSLOVAK NUCLEAR POWER PLANT A-1. Paulicka, I.; Vorisek, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu); Wagner, K. (Skoda Works, Pilsen (Czechoslovakia)). Jun 1971. 18p. (CONF-710901–359). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The physical startup of the A-1 reactor follows after individual and complex testing of the equipment. The primary power plant circuit, including the reactor, is tested with respect to leakage and pressure, the operation of circulation pumps is checked, etc. Each fuel element is substituted by the mock-up fuel element of corresponding weight and hydraulic resistance, equipped with non-standard measuring instrumentation. The physical startup, which is described, is carried out after finishing these tests and after the elimination of the imperfections. During the physical startup the reactor criticality is reached for the first time. After the physical startup the stage of a stepwise power increase follows until the nominal thermal power of the reactor is reached. During this process an operational checking of the equipment is carried out. The physical startup is planned to be accomplished approximately during 6 weeks. The operational staff of the power plant organize the work connected with the startup. 4 references. (auth)

53948 (A/CONF.49/P–575) INCIDENTS THAT OCCURRED TO THE REACTOR OF THE ARDENNES NUCLEAR POWER PLANT. Kiefer, J.; Erkes, P. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)); Aboud-haram, L.; Evenepoel, R.; (and others) May 1971. 23p. (In French). (CONF-710901–244). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Ardennes nuclear power plant (P.W.R.–266 MW(e)) was shut down during two years six months after it was connected to the grid when in early 1968 damages were detected in the internals of the reactor. The origin of the hydrodynamic vibrations which, when applied to the internal structure of the reactor in service, caused an unsteady rocking of the "thermal shield" and the stress rupture of several assembling parts is analyzed. The remote repair methods to dismantle the thermal shield, replace the broken or doubtful bolts, and check the fuel elements are described. After completion of these tasks and before putting the plant effectively back into service, a campaign of static and then dynamic tests was performed. (auth)

53949 (A/CONF.49/P–673) START-UP AND OPERATIONAL EXPERIENCE WITH THE FIRST TWO SWISS NUCLEAR POWER STATIONS BEZNAU AND MUEHLEBERG. Kueffer, K. (Nordostschweizerische Kraftwerke A.G., Baden (Switzerland)); Lutz, H. R.; Rognon, J.; Stoll, P. (Bernische Kraftwerke A.G., Bern (Switzerland)). Jul 1971. 27p. (CONF-710901–494). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The preliminary acceptance run of the first commercial nuclear power plant in Switzerland, Beznau I (350 MWe) was started on September 6, 1969 after a construction period of 48 months. On December 24, 1969 Beznau I started commercial power production. Accumulated power production delivered into the NOK (Nordostschweizerische Kraftwerke AG) grid was more than $2.5 \cdot 10^9$ KWh by the end of 1970. The startup of Beznau I was accomplished without significant problems. The test results of the startup program compared very favorably with the calculated values. A sudden increase of the radioactivity level in the primary coolant system was detected. The radioactivity increase was a result of the defects in the Zircaloy cladding. This radioactivity increase led to the first

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significant operational difficulties of the power plant: relatively high air contamination and an increase of the radioactivity level in certain areas of the primary plant building was found. The collection and disposal system for radioactive waste (liquid and gas) imposed some impasses. The commercial operation of Beznau I was quite satisfactory during the first quarter of 1970, regardless of the above mentioned difficulties. The availability of turbosets 1 and 2 was 98.2 and 99.2%, respectively. In the middle of October 1970 a radioactivity increase in the secondary system was detected. The plant was shut down at the beginning of November to repair the approx. 200 l/day leak in one of the steam generators. The repair was completed very fast, i.e., within 10 days. The plant however could not get started before January 1971. The reasons for the startup delay were as follows: leaks in the steamgenerator man ways, fracture in a main turbine stop valve shaft, the sealrings of the main reactor coolant pumps were jammed and a corrosion spot on the reactor vessel head was detected. The corrosion on the reactor vessel head was thoroughly investigated. The construction of Beznau II nuclear power plant, in principle a duplicate of Beznau I, is on schedule and so far all the construction stages have been completed without problems. The total construction time of Beznau II is expected to be a couple of months less than that of Beznau I. The beginning of the preliminary acceptance run is expected for fall 1971. (3 references.) (auth)

53950 (A/CONF.49/P–675) ROLE OF NUCLEAR PLANT IN A WATER POWER SYSTEM: EXPERIENCE AND PROSPECTS IN SWITZERLAND. Goldsmith, K. (Electro-Watt Engineering Services Ltd., Zurich (Switzerland)); Luder, H. A. (Laufenburg Electricity Supply Co., (Switzerland)). Jun 1971. 14p. (CONF-710901–410). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Two nuclear stations are now in operation and one is under construction. Three additional stations are being planned, giving an aggregate output capacity of 3500 MW (around 40% of the country's total demand) by the end of this decade. The introduction of this large block of base-load plant will have a significant effect on the national power production pattern. Careful phasing is required to achieve proper operational coordination between nuclear and run-of-river hydro plants and to ensure that surpluses can be exported and output restrictions avoided. The demand of intermediate merit, between baseload and peak-load, calls for prudent managment of hydro storage coupled with the import of thermal energy surpluses from neighboring countries. Finally, the role of the storage schemes for peak load coverage, both inland and abroad, requires re-appraisal to safeguard their optimum use. The need to extend their capability by more pumped storage requires examination. This paper deals with these matters and considers in particular in what way the growing proportion of nuclear plants in the Swiss system will influence the power exchanges with neighboring countries. (auth)

53951 (A/CONF.49/P–716) OPERATION OF CHANNEL-TYPE URANIUM-GRAPHITE REACTORS WITH NUCLEAR STEAM SUPERHEATING. Aleshchenkov, P. I.; Veselkin, A. P.; Dollezhal, N. A.; Evdokimov, J. V.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 20p. (CONF-710901–420). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The principal results of seven years operation of the Beloyarsk Nuclear Power Station (BNPS) with nuclear steam superheating are presented. The factors of installed power and time utilization, planned and accidental shutdowns, and an analysis of shutdown reasons are included. The fuel channel (FC) operating conditions are considered. The conditions and operation results are discussed for graphite, water treatment and water-chemical operating conditions of the nuclear power station, and the experience in adjustment and mastering of the automated "Karat" system at the 2nd unit of the BNPS. The statistics and reasons are analyzed for fuel channel failures, and different improvements to increase the FC reliability are discussed. Data are presented on radiation conditions under power operation and during shutdowns. The coolant radioactivity and radioactive deposits on equipment surfaces are considered. Data are reported on the nuclear power station radioactivity discharges into the atmosphere, on radioactive wastes, and the effects of both on the environment. The peculiarities and some advantages of this reactor type are considered from the viewpoint of nuclear power station radiation safety. (auth)

53952 (A/CONF.49/P–735) EXPERIENCE WITH NUCLEAR POWER PLANTS IN SPAIN. Cervera, J. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)); Lopez-Rodriguez, M. (Junta de Energia Nuclear, Madrid (Spain)); Pardo, J. J. (Union Electrica, S. A.). Jun 1971. 11p. (In Spanish). (CONF-710901–506). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The experience derived from the operation of the Jose Cabrera Reactor until the end of the first fuel cycle, in April 1971, and the subsequent refueling operation is described. The plant has produced more than 2000 million kWh during this first cycle. The nominal rating of 160 MWe, maximum authorized power, was first attained in November 1969. This is the power guaranteed by the vendor three years after start of operation. The station has operated at the maximum power for extended periods of time. After one and one half years of commercial operation the performance of the José Cabrera Plan can be considered very successful. The Santa Maria de Garoña plant, owned by Nuclenor, is of the BWR type and has been built by General Electric. Construction work started in November 1966 and full power was reached last April. This paper deals with the problems that developed during preoperational testing and startup, the solutions adopted and the experience obtained during the early months of operation. (auth)

53953 (A/CONF.49/P–760) SMALL AND MEDIUM POWER REACTORS: TECHNICAL AND ECONOMIC STATUS, POTENTIAL DEMAND AND FINANCING REQUIREMENTS. Khan, Munir A.; Roberts, J. Tom (International Atomic Energy Agency, Vienna (Austria)). Jul 1971. 24p. (CONF-710901–463). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

53954 (A/CONF.49/P–764) PRACTICAL ASPECTS OF NUCLEAR FUEL SERVICES MANAGEMENT. Avery, D. G.; Carter, P. E. (British Nuclear Fuels Ltd., Risley (England)). Jun 1971. 13p. (CONF-710901–425). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The provision of fuel services to a nuclear power program involves a number of processing stages, all of which require, on an industrial scale, capital intensive plants. Furthermore, the high intrinsic value of the material being processed places a substantial premium on maintaining minimum inventory. In addition, the nuclear industry is still at a stage where frequent changes in technology as well as wide fluctuations in demand are major characteristics. Substantial economies in processing costs can be achieved by optimizing production programs, by careful planning of capital investment, and by the integration of the various processing stages to give maximum operational flexibility. The particular problems associated with each processing stage from purification through to fabrication and reprocessing are reviewed. The techniques available for scheduling and stock optimization of the various stages are examined and some of the lessons learned from experience to date are noted. An account is then given of the overall method by which nuclear fuel production is controlled in an organization which includes all the stages within the nuclear fuel cycle. Finally, the planning of capital investment in this field is discussed with particular reference to the uncertainties that have to be faced in forward forecasting and the extent to which modern techniques for investment appraisal can be utilized in this field. (auth)

53955 (A/CONF.49/P–802) NUCLEAR POWER FORECAST FOR BRAZIL. Castro, J. C.; Lepecki, W. P. S.; Marques de Souza, J. A.; de Moraes Filho, J. E. (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro). Jun 1971. 25p. (CONF-710901–431). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A forecast of nuclear power development in Brazil up to the end of the century is given. The main requirements to back up such a nuclear program are outlined. Owing to its overwhelming importance in the electric energy market in Brazil, the South-Central Region is chosen as the area under study, but the results are largely representative of the country as a whole. The generating capacity of the region relies heavily on hydro power, but both the coming exhaustion of economic hydro sites, and the need for firming the continuous energy of the system, point to the necessity of a program of thermal power plants, in which a considerable portion could be nuclear. A mathematical model of the expanding electric system is employed in order to determine the optimum mix of hydro, conventional and nuclear power plants. The relative location of hydro sites along a river basin is taken into account in order to assess their mutual influence through the regulation of the river. A parametric study is made in order to assess the influence of input data on the resulting nuclear program. Taking one of the thermal complement programs as a reference case, different reactor strategies are analyzed. The industrial support necessary to carry out the reference nuclear program is discussed. 23 references. (auth)

53956 (A/CONF.49/P–803) INTEGRATION OF SECOND NUCLEAR POWER PLANT IN ELECTRIC NETWORK OF TAIWAN, REPUBLIC OF CHINA AS A MEANS OF LOWERING THE COST OF DELIVERED POWER. Chu, David S. L. (Taiwan Power Co., Taipei). Apr 1971. 14p. (CONF-710901-335). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Taiwan Power Company has started construction of its first and second BWR nuclear units each rated at 636 MW(e) gross, scheduled for commercial operation by the end of 1975 and 1976 respectively. These two units will represent about 20% of the total installed capacity of the 1976 Taipower system. The economic and financial studies that led to the above decision are presented. Three alternative expansion plans each with different date of nuclear application were contemplated to meet the projected load. The revenue, operation expenses, and investment schedule of each alternative plan were assessed to evaluate the future company-wide financial status. The comparative service cost at consumer's end demonstrates an advantage of earlier nuclear implementation in lowering the system production cost. (auth)

53957 (A/CONF.49/P-806) EXPERIENCE GAINED IN THE OPERATION OF THREE DEMONSTRATION NUCLEAR POWER STATIONS IN THE FEDERAL REPUBLIC OF GERMANY AND PROGRESS IN THE DEVELOPMENT OF NEW PLANTS UNDER CONSTRUCTION. Deublein, O. (Kernkraftwerk Lingen G.m.b.H., (West Germany)); Keller, W. (Siemens A.G., Erlangen (West Germany)); Kornbichler, H. (Allgemeine Elektricitaets-Gesellschaft, AEG-Telefunken, Frankfurt am Main (West Germany)); Schenk, H.; (and others) Apr 1971. 18p. (CONF-710901-336). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

To the development of light-water reactors the Federal Republic of Germany has contributed ten plants having a total capacity of about 5000 MW(e), which are either already operative or in course of construction. Four of these plants with a total capacity of 800 MW(e) will, by the middle of this year, have given about 20 years of most valuable experience in the operation of reactors. Particular importance is attached to the experience gained with the three large demonstration power plants at Gundremmingen (250 MW(e)), Obrigheim (345 MW(e)) and Lingen (254 MW(e)) because these represent the transition to the present commercial utilization of nuclear energy for the supply of electricity. With these plants it has been demonstrated that their operational behavior guarantees the successful use of nuclear power stations for the public power supply. Defects which occurred occasionally in the nuclear steam generating systems proved capable of being quickly and easily repaired and were shown to be avoidable for future plants. Thus a very high degree of availability can justifiably be expected for the nuclear power stations under construction and on order. (auth)

53958 (A/CONF.49/P-849) EXPERIENCE IN CONSTRUCTION AND OPERATION OF COMMERCIAL NUCLEAR POWER STATION IN JAPAN. Nomura, Akio; Tsukuda, Toshio; Yoshioka, Toshio (Japan Atomic Power Co., Tokyo). May 1971. 14p. (CONF-710901-350). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The advent of commercial nuclear power stations in Japan began with construction of the Tokai Power Station, and as of March 1971, four stations with a total generating capacity of 1,323 MW(e) are in operation and nine stations with a total generating capacity of 5,803 MW(e) are under construction. The Tokai Power Station, which is of British GCR type, owned by the Japan Atomic Power Company, started commercial operation in July 1965 with a max. output capacity of 166 MW. The Tsuruga Power Station, which is of U. S. BWR type, owned by the Japan Atomic Power Company, started commercial operation in March 1970 with an output capacity of 357 MW. The Mihama Power Station, which is of U. S. PWR type, owned by the Kansai Electric Power Co., Inc., started commercial operation in November 1970 with an output capacity of 340 MW. The Fukushima Power Station, which is of U. S. BWR type, owned by the Tokyo Electric Power Co., Inc., commenced operation in March 1971 with an output capacity of 460 MW. Out of these, as for the Tokai Power Station, a description is made mainly of its operational experience, particularly of various troubles which occurred on the reactor primary circuit and tube corrosion problem of the steam rising units, touching on briefly how these problems have been solved. As regards the Tsuruga Power Station, the experience gained through the operation and annual inspection of almost one year period after start of its commercial operation is discussed. Lastly, referring to the Mihama and Fukushima Power Stations, major events encountered during the construction and pre-operational test periods are described in some detail. (auth)

53959 (DOCKET-50003-88) INDIAN POINT STATION, UNIT NO. 1. Control Rod Position Failure. (Consolidated Edison Co. of New York, Inc., New York). 2 Sep 1971. 4p. Dep. NTIS.

53960 (DOCKET-50133-67) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Failure of Emergency Condenser Condensate Return Valve. (Pacific Gas and Electric Co., San Francisco, Calif.). 13 Sep 1971. 2p. Dep. NTIS.

53961 (DOCKET-50171-93) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 64, June 1971. (Philadelphia Electric Co., Pa.). 9 Sep 1971. 20p. Dep. NTIS.

53962 (DOCKET-50206-123) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Semiannual Operating Report No. 8, January 1-June 30, 1971, Addendum. (Southern California Edison Co., Los Angeles). 2 Sep 1971. 2p. Dep. NTIS.

Conversion factors for radioactive effluent calculations for the San Onofre Power Reactor Unit 1 are presented. (D.C.C.)

53963 (DOCKET-50237-199) DRESDEN NUCLEAR POWER STATION, UNIT 2. Partial Control Rod Insertion Following Spurious Reactor Scram Signal. (Commonwealth Edison Co., Chicago, Ill.). 8 Sep 1971. 9p. Dep. NTIS.

53964 (DOCKET-50244-77) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Semiannual Report No. 3, December 26, 1970-June 25, 1971. (Rochester Gas and Electric Corp., N. Y.). 8 Sep 1971. 29p. Dep. NTIS.

53965 (DOCKET-50261-72) H. B. ROBINSON UNIT NO. 2. Leak Developed in Main Coolant Sample Cooler on August 22, 1971. (Carolina Power and Light Co., Raleigh, N. C.). 27 Aug 1971. 1p. Dep. NTIS.

53966 (DOCKET-50266-54) POINT BEACH NUCLEAR PLANT, UNIT NO. 1. Improper Startup Reactor Trip Setpoints. (Wisconsin Electric Power Co., Milwaukee). 13 Sep 1971. 3p. Dep. NTIS.

53967 (WAPD-PWR-TE-206) SHIPPINGPORT PWR CORE 2, SEED 1 PHYSICS TEST RESULTS FROM MIDLIFE TO END-OF-LIFE TEST EVALUATION. Smith, F. E. (Bettis Atomic Power Lab., West Mifflin, Pa.). Mar 1970. Contract AT(11-1)-Gen-14. 49p. Dep. NTIS.

The results of physics tests conducted during the second half of PWR Core 2 Seed 1 lifetime are presented. The period of these tests covers operations from December 1966 to the completion of 13,652 equivalent full power hours in March 1969. These tests have provided information on critical rod positions and reactivity worths, temperature coefficients, xenon transient characteristics and reactivity loss rates. Calculated characteristics of the core were found in general to be in good agreement with the measured nuclear characteristics. (9 references) (auth)

53968 (WAPD-PWR-TE-260) SHIPPINGPORT PWR CORE 2, SEED 2 PHYSICS TEST RESULTS FROM BEGINNING-OF-LIFE THROUGH 172 EQUIVALENT FULL POWER HOURS OF OPERATION TEST EVALUATION. Smith, F. E. (Bettis Atomic Power Lab., West Mifflin, Pa.). Feb 1970. Contract AT(11-1)-Gen-14. 33p. Dep. NTIS.

The results of physics tests conducted with PWR Core 2 following replacement of the expended Seed 1 with Seed 2 and during the first 172 equivalent full power hours of operation are presented. These tests, which were performed between June 16 and July 20, 1969, have provided information on critical rod positions and reactivity worths, reactivity coefficients, xenon transient characteristics and reactivity symmetry. Measured results are compared with calculated data and with measured data for PWR Core 2 Seed 1. (7 references) (auth)

53969 SPECIAL ASPECTS OF RELIABILITY AND MAINTAINABILITY IN NUCLEAR STATIONS. Wolfe, W. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Microelectron. Rel.; 10: No. 3, 217-23(Jun 1971).

Failure of pumps in a hypothetical heat transport system is considered to illustrate the importance of reliable constituent components in keeping a nuclear power station operational. The time before failure of the pump components, and thus the probability of a pump completing its run without failure, is considered. The effect on the reliability of the system of standby pumps and the repair time needed for those which failed are discussed. The problem of impedance of repair work by radiation hazards to personnel is also considered. Remedies for maintenance difficulties are suggested, chiefly through greater understanding of the problem at all levels in design work. Desirable information about the reliability and maintainability of components is listed and exchange of suitable information between customer and supplier as an aid to reliability assessment suggested. (UK)

53970 OPERATING EXPERIENCE AT THE DRESDEN 2 REACTOR. Steele, Myrna L. (Atomic Energy Commission, Oak Ridge, Tenn.). Reactor Technol.; 14: No. 3, 225-32(Fall 1971).

The highlights of operation of Unit 2 of the Dresden Nuclear Power Station from startup through December 1970 are summarized, and maintenance and repair activities are listed. 9 references. (auth)

53971 OPERATING EXPERIENCE AT THE ENRICO FERMI FAST BREEDER REACTOR. Steele, Myrna L. (Atomic Energy Commission, Oak Ridge, Tenn.). Reactor Technol.; 14: No. 3, 233-6(Fall 1971).

Operations and the maintenance and repair activities for the Enrico Fermi Fast Breeder Reactor are summarized for the period from mid-July through December 1970. 5 references. (auth)

Safety and Siting

Refer also to abstracts 52043 and 52065.

53972 (A/CONF.49/P-173) SOLUTIONS OF SAFETY PROBLEMS ENCOUNTERED IN THE OPERATION OF THE ITALIAN NUCLEAR POWER PLANTS. Iansiti, Enzo (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)); Lepore, Ro molo (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). May 1971. 33p. (CONF-710901-183). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The operation of the Italian nuclear power plants has allowed ENEL and CNEN to gain a considerable amount of experience in the field of nuclear plant safety. Some of the main problems encountered during the operation are described. The solutions adopted are presented. In solving these problems, including the most critical ones, the main scope has been to continue the plant operation maintaining the safety margin at a level comparable with the design values. Some modifications are described which have been introduced in the plants in order to improve their safety standards. (auth)

53973 (A/CONF.49/P-191) RADIATION PROTECTION EXPERIENCE IN ITALIAN NUCLEAR POWER PLANTS. Cometto, M.; Toccafondi, G. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)); Ilari, O.; Tagliati, S. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1971. 29p. (CONF-710901-157). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A summary is provided of the provisions of the Italian legislation for protection of workers and population against the hazards of ionizing radiation, with special reference to nuclear plants. The breadth of the experience acquired in Italy with radiation protection problems in nuclear plants is presented and discussed in relation to the operating experience accrued over nearly ten years of operation of the three ENEL power plants. The methods and main criteria adopted at the Garigliano, Latina and Trino Vercellese plants for radiation protection under normal operating conditions and during major maintenance jobs are described, with emphasis on the milestones in the evolution of operational health physics and protection procedures, and the present criteria for dosimetric checks on the personnel and work areas are discussed in relation to the latest ICRP recommendations. Also discussed is the evolution of the radiation protection criteria concerning radioactive waste disposal and control of ambient contamination. The positive results of the precautionary provisions adopted are examined in terms of individual and collective doses of environmental pollution. 8 references. (auth)

53974 (A/CONF.49/P-226) STATE OF ARTS IN ASEISMIC DESIGN OF NUCLEAR POWER PLANTS IN JAPAN. Udoguchi, Teruyoshi (Tokyo Univ. (Japan)); Ohsaki, Yorihiko; Shibata, Heki. May 1971. 13p. (CONF-710901-91). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A method for determining the design ground movements which have been applied to Japanese power plants, a summary of the criteria for earthquake resistant design in practice, and a proposal for improving the practice which involves subjects needing further studies are presented. Important subjects among the latter are the dynamic analysis of equipment and piping and their allowable stresses under earthquake loading. (auth)

53975 (A/CONF.49/P-272) SAFETY ASPECTS OF THE DOEL AND TIHANGE POWER PLANTS. Dozinel, P.; Dresse, H. May 1971. 15p. (CONF-710901-194). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The DOEL (2 × 390 MW(e)) and TIHANGE (870 MW(e)) nuclear power plants are being built in densely populated areas, as will be the case for numerous nuclear power plants to be erected in industrialized countries. Examination of the studies undertaken in Belgium and of the solutions adopted in the choice of equipment and protection systems is therefore a matter of general interest. At DOEL, the twin units lay-out has important consequential effects as to safety circuits and devices. Reactor containments have double envelopes: a pressure-resistant steel sphere and a concrete shield cylinder. The safety equipment peculiar to the plant (emergency power and coolant water supply, etc.) are treated in detail, as are the solutions provided for the accessibility with a view to periodical checks, for the sections containing the pipe supports and welds of the reactor vessel. Concrete structures inside the containment have been designed so as to take into account the latest safety criteria for avoiding an aggravation of the consequences of a pipe-rupture. At TIHANGE, as the plant is located in a relatively narrow valley, detailed meteorological investigations have been undertaken. It is shown how the systematic use of measurements carried out for several years by means of a high mast, confirmed by traced releases, has made it possible to define the atmospheric dilution coefficient applicable to the plant effluents. The solution adopted for the reactor containment and associated systems (cooling pool, fuel transfer, spray system, filtration, chimney, etc.) is described. The advantages shown by a double containment, whose inner envelope is of pre-stressed concrete and the outer one of reinforced concrete, are put forward and the original character of this conception is emphasized. (auth)

53976 (A/CONF.49/P-304) NUCLEAR POWER STATION SAFETY AND THE RESPONSIBILITY OF UTILITIES. Jungnell, D.; Nistad, J.; Schultz, G. (Swedish State Power Board, Stockholm). May 1971. 9p. (CONF-710901-266). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

It is shown with examples what the approach of the Swedish State Power Board has been in specific cases. Among these can be mentioned, in particular, the release policy for gaseous radioactivity and the principle of complete separation between redundant trains in safety systems which implies features in the layout and structure that goes beyond most current practice. (auth)

53977 (A/CONF.49/P-305) CONTAINMENT AND SAFETY IN SWEDISH NUCLEAR POWER PLANTS. Isberg, Pelle (ASEA-ATOM, Vasteras (Sweden)). May 1971. 8p. (CONF-710901-267). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

ASEA-ATOM has been requested by the Swedish Reactor Safety Committee to follow the USAEC ground rules for nuclear safety. A review is given of the possibilities and difficulties encountered when utilizing in this way the standards of a foreign body to which access for review is not granted. In the area of normal operation at release of radioactive matter from nuclear power plants the Swedish policy is developing somewhat differently from that in some other countries. Where the current trend is to lower the permissible exposures of the nearest man, Swedish rules will probably concentrate on the lowering of population exposures. What this means to the nuclear plant designer is discussed. One contribution of ASEA-ATOM to nuclear safety is in the field of reactor containment vessel integrity. The background of the imbedded liner concept and other features of the concrete pressure suppression containment vessel are reviewed. The basic philosophy of the Värtan underground plant design is also presented. (auth)

53978 (A/CONF.49/P-306) INTEGRATION OF NUCLEAR UNITS IN THE SWEDISH POWER SYSTEM. Holmin, N.; Johansson, T.; Jungnell, D.; Wedeen, A. (Swedish State Power Board, Stockholm). May 1971. 9p. (CONF-710901-268). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

As most of the economic hydro power resources are now harnessed, the future power increase in Sweden will be covered by thermal power. The nuclear power is forecast to be about 7000 MW at the end of the 1970's. An optimization study shows the economic size of the nuclear power units in the Swedish network during 1970's will be up to 800 MW. It is important that the large nuclear units have a good regulation capability during normal operation as well as during disturbances, that they have short starting times, and that they can survive voltage and frequency changes. The extent the nuclear power stations can fulfill these demands from the network is described. Since increased demands will cause larger costs the reasonableness of these demands is also discussed. (auth)

53979 (A/CONF.49/P-396) ACTIVITY RELEASE AND CONTROL AT THE NUCLEAR POWER STATIONS. Boedege, R. (Kernkraftwerk Lingen G.m.b.H. (West Germany)); Eickelpasch, N. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)); Grau, A.; Stephan, W. Apr 1971. 18p. (CONF-710901-140). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The activities to be handled at these stations are shown in diagrams differentiating them by origins and concentrations. The methods applied in measuring the activities in the released waters and gases, and also those applied in surveying the environments, are described. Special problems of these measurements are mentioned. The activities released from these stations are given from the beginning of their operation up to 1970 and are compared to the limiting values fixed by the licences. The influences of special operation states on the activity releases are illustrated. The activity concentration in the primary water (e.g. in case of can damages) and the leakages from those loops containing primary water roughly determine the release. The interdependency of the licence conditions and the operation of a nuclear station are discussed. The sensitivities in measuring the environmental contamination are sufficiently high, and no marked influences of these stations on their environments are established. (auth)

53980 (A/CONF.49/P-399) ENVIRONMENTAL EXPOSURE BY RADIONUCLIDES IN GASEOUS AND LIQUID EFFLUENTS FROM NUCLEAR POWER PLANTS IN THE FEDERAL REPUBLIC OF GERMANY. Aurand, K. (Bundesgesundheitsamt, Berlin (West Germany)); Ruf, M.; Schikarski, W.; Schwibach, J. Apr 1971. 24p. (CONF-710901-141). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The operating experience of the nuclear power plants in the Federal Republic of Germany is reviewed. An assessment of the expected environmental exposure by radionuclides in effluents from nuclear power plants is presented. As to the expected increase in the number of nuclear power plants in the next decades radionuclides in effluents will certainly cause only a comparatively low radiation exposure of the population. 7 references. (auth)

53981 (A/CONF.49/P-505) RADIOLOGICAL CONDITIONS AND EFFLUENT RELEASES AT CENTRAL ELECTRICITY GENERATING BOARD NUCLEAR STATIONS: A COMPARISON BETWEEN DESIGN FORECASTS AND OPERATIONAL EXPERIENCE. Pepper, R. B. (Central Electricity Generating Board, London (England)); Carter, P. A. (Central Electricity Generating Board, Somerset (England)). May 1971. 11p. (CONF-710901-224). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

During the design and early construction stages of seven commercial Mk I Gas Cooled Reactor (Magnox) power stations, estimates were made of dose-rates that would occur on and around the site and in operational and maintenance areas of the reactor buildings. Existing data were used in calculations to predict the quantities of radioactive liquid and gaseous effluents, and proposals were made for contamination control systems. Comparisons made between these various estimates and the values measured during operation, show that the shielding proved to be more effective than anticipated. The doses received by classified workers are presented and discussed. The system of contamination control was found to be over-cautious and a description is given of the simpler arrangements adopted. Liquid waste arisings have contained unexpected quantities of caesium, tritium and sulphur and the consequences of this are reported. Gaseous effluent discharges have not presented problems. A brief discussion is given of the implications of this experience for health physics control and for aspects of design of future power reactors. 9 references. (auth)

53982 (A/CONF.49/P-536) NUCLEAR OPERATIONS IN RURAL INDIA AND CONSERVATION OF AQUATIC ENVIRONMENT. Kamath, P. R.; Bhat, I. S.; Ganguly, A. K. (Bhabha Atomic Research Centre, Bombay (India)). May 1971. 28p. (CONF-710901-299). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

There is great enthusiasm for nuclear power in the less developed but populated regions in the country. There exists at the same time a genuine concern regarding deleterious effects from radioactive releases. This imposes the responsibility of selection of proper sites and demands careful safety evaluation of a project. Safety criteria ensure that populations are not likely to be exposed above the permissible levels and no undue restrictions are imposed on utilization of the environment. Development of nuclear resources in the widely scattered operational sites in the country also pose problems of disposal of effluents containing sulphates, manganese, and radium from uranium ore milling and tailings disposal; nitrate, fluorides and ammonium salts from fresh fuel manufacture and fission products from fuel reprocessing. Enforcement of controlled release is effected by site Environmental Survey Laboratory (ESL), working independently of the operating organization. Offshore and ground waters receiving effluents often move beyond exclusion area. Large volumes of coolants and processing effluents for discharge impose severe restrictions because of thermal and other kinds of pollution specially into inland waters which are generally in short supply to meet the local and irrigational demand. Alternate arrangements for complete containment are enforced at places. Field investigations are conducted to determine dilution, dispersion and ecological reconcentration of pollutants and to determine safe recipient capacity of an environment. Monitoring of indicator matrices shows up an approaching build up of pollution long before unacceptable conditions can be reached. Whole body radiation monitoring of selected groups of population is a routine at ESL and has received enthusiastic response from local population. Demographic and site studies at Tarapur and other areas have enabled ESL to establish an enlightened rapport with the public and study regional peculiarities. Easy accessibility of ESL for free discussions, and availability of environmental data and findings, have contributed to inspire trust and receive valuable public co-operation. 8 references. (auth)

53983 (A/CONF.49/P-543) NUCLEAR POWER PLANTS SITING IN THE CZECHOSLOVAK SOCIALIST REPUBLIC. Beranek, J.; Kriz, Z. (Ceskoslovenska Akademie Ved, Prague); Chochlovsky, I.; Raisigl, C.; (and others) May 1971. 36p. (CONF-710901-237). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Czechoslovakia as a country with high population density and extended industry prefers to develop nuclear power plants with maximum reliability and safety. In all phases of design, construction, and operation of nuclear power plants, standards and regulations issued by the Ministry of Health and the Czechoslovak Atomic Energy Commission are strictly and carefully followed. For actual siting two different approaches are used: (1) the siting in relatively isolated locations, i.e., nuclear power plants without containment, surrounded by exclusion areas, with maximum emphasis on reliability of all components; and (2) the siting of nuclear power plants (particularly for heating purposes) directly in highly populated areas. This approach demands the use of a well-proven type of reactor with double containment and all engineered safeguards. (auth)

53984 (A/CONF.49/P-579) FRENCH TENDANCIES ABOUT REACTOR SAFETY. Bourgeois, J.; Candes, P.; Clement, B.; Costes, D.; (and others) (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1971. 10p. (CONF-710901-398). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

After the "maximum hypothetical accident" method followed around the world until recent years, and wating the moment when the British probability method will be made very fruitful through improvements in reliability information, accident processes knowledge and risk level acceptability in accordance to public opinion, we have chosen an analytical method for safety evaluations. Our method allows objective pointing out of safety choices and easy permanent exchanges at each stage between design, construction and operation teams and safety responsibilities; it is based on a continuous analysis of availability and potential accident behavior of each barrier provided between dangerous products and public. The review is quantified when possible and qualitative in other cases. (auth)

53985 (A/CONF.49/P-660) FORECASTING THE ROLE OF NUCLEAR ENERGY IN SOUTH AFRICA. Tremeer, G. E. B.; Maunders, E. J. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). May 1971. 15p. (CONF-710901-313). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Several features of the South African situation make the forecasting of the role of nuclear energy more complex than in the highly developed countries of Western Europe. The unique features which contribute to this are (1) the existence of five geographically

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well-separated load centers averaging over 500 km apart (two inland and three on the coast), (2) only one large low-cost coal reserve, this being at one of the inland centers, and (3) limited inland water resources. A computer model was therefore developed to simulate, under these conditions, the present electrical generation system, and its possible expansion over the next 30 years. The model uses the present worth method to evaluate alternative modes of system expansion, based on forecasts of regional load growth. Transmission line costing is treated quite generally, for example, intermediate load take-off points on long lines and discontinuous cost functions are considered. Dry-cooled units can be added to the system from a specified date. Plant items are sorted in order of merit, although, if desired, hydro units can be run at specified annual load factors. The introduction of natural and enriched uranium reactors with and without fast breeders was studied. The results show that it will be economic to aim for a relatively large nuclear installation program commencing in 1980. Based on locally produced plutonium, fast breeders cannot be installed until the last decade of the century. Details are given of the sensitivity of the results to variations in coal price and nuclear fuel cycle costs. (auth)

53986 (A/CONF.49/P-681) ENVIRONMENTAL EFFECTS: PUBLIC RELATIONS. Robin, A.; Leo, B. (Electricite de France, Paris); Renou, J.; Gauvenet, A. (Commissariat a l'Energie Atomique, Paris (France)). Aug 1971. 9p. (CONF-710901-458). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Nuclear power plants are equipped with efficient safety devices and various containment buildings which, in fact, completely protect the public against any radioactivity hazard. No industrial facility is so thoroughly controlled and inspected during both construction and operation. No notable radioactivity dispersion has been observed around the nuclear power plants, even on the occasion of the very few incidents which have occurred in the first experimental plants. Some uneasiness has spread out into the public, obviously not able to make a judgement about the degree of safety. Opposition campaigns have been launched. They are very often based on false or incomplete interpretation of actual or plausible facts. They sometimes make use of statistical data which is wrongly interpreted. It is necessary, to avoid the spreading of this opposition, to inform the public at large of the conditions in which the nuclear power plants are built and operated. This information is disseminated by public relations departments and must, to be understood, adopt common language and be based on comparison with known facts. (auth)

53987 (A/CONF.49/P-687) RADIATION MONITORING SYSTEM FOR WATER-COOLED NUCLEAR POWER PLANTS. Zhernov, V. S.; Kiselev, B. L.; Matveev, V. V.; Pologih, B. G.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 25p. (CONF-710901-414). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Radiation control system functions are grouped as follows: coolant condition estimate (fuel element sealing control, efficiency of purification system, decontamination efficiency, corrosion products activity etc.), check-up of equipment pressurization (pressurization control of steam generators and auxiliary heat exchangers primary circuits pump and vessel pressurization etc.), check-up of waste discharge levels (control of gaseous-aerosol mixture release, water discharge of purification system efficiency etc.), radiation conditions estimation in and out of premises (surface contamination control, analyses of liquid, loose and solid samples etc.), check-up of exposure rates (chronic external irradiation planned increased external radiation, internal personnel irradiation etc.). The control is mostly provided by centralized information and measuring system of radiation control, ensuring operational remote control of radiation characteristics. Coolant conditions are estimated by means of krypton-88 gamma emission measurement, pressurization of steam generator primary circuit is checked by means of N-16 beta-ray measurement directly in secondary circuit; pressurization of pumps and vessels is checked by beta-active gas measurement. Radiation conditions are estimated by the use of gamma-ray and neutron remote measurements, radiation rates are controlled by personal dosimeters with automatic measurement and recording as well as personal teledosimeters and man radiation counter. Control of equipment surface contamination as well as of body and clothes is carried on with portable and stationary instruments; sample isotopic composition is determined by the use of pulse-height analyzer. 5 references. (auth)

53988 (A/CONF.49/P-734) NUCLEAR SAFETY IN SPAIN. de los Santos, Alfonso; Corretjer, Luz (Junta de Energia Nuclear, Madrid (Spain)); Bellido, Pedro Trueba; de Buergo, Luis Alvarez; Santos, Agustin Alonso (Junta de Energia Nuclear, Madrid (Spain). Seccion de Seguridad Nuclear). May 1971. 9p. (In Spanish). (CONF-710901-505). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The report describes the basic principles followed in Spain to assure that siting, design, construction and operation of Nuclear or Radioactive Installations is done without undue risk. The safe transport of radioactive materials and nuclear fuels is also included. The 25/1964 law on nuclear energy establishes these basic principles, the law also regulates the administrative ways to be followed in requesting and granting licenses. The basic principles in the law are fully developed in corresponding detailed regulations. (auth)

53989 (A/CONF.49/P-799) DECONTAMINATION OF EQUIPMENT AND SURFACES, CONTAMINATED DURING THE OPERATION OF NUCLEAR POWER PLANTS WITH WATER-COOLED REACTORS. Sedov, V. M.; Simanovskii, Yu. M.; Smirnov, V. V.; Ugryumov, M. V. (State Atomic Energy Committee, USSR). Aug 1971. 24p. (CONF-710901-466). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

53990 (A/CONF.49/P-848) CURRENT TRENDS IN RADIOLOGICAL PROTECTION BY ELECTRICITE DE FRANCE IN ITS NUCLEAR POWER PLANTS. Delpla, M.; Beau, P.; Bertron, L.; Martin, J. J.; (and others) (Electricite de France, [Paris]). Jun 1971. 23p. (CONF-710901-436). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

By the end of this year, Electricite de France will be operating eight nuclear power plants distributed over five different locations and representing an installed power in excess of 2500 MWe. Although they belong to different types, the radiation protection organization in all of these nuclear plants is based upon the same principle: set at the same level as all other risks, the nuclear hazards are treated according to the same guiding principles as the others. The experience enabled an overall consideration and an analysis of the real hazards created by a nuclear plant in operation. 5 references. (auth)

53991 (DOCKET-50010-94) DRESDEN NUCLEAR POWER STATION, UNIT 1. Technical Specifications, Change No. 23 Allowed. (Division of Reactor Licensing (AEC), Washington, D. C.). 8 Sep 1971. 8p. Dep. NTIS.

Revised technical specifications are presented concerning the use of respiratory protective equipment for personnel in restricted areas of the reactor site. Protection factors concerning the respiratory equipment are listed. (D.C.C.)

53992 (DOCKET-50237-144) DRESDEN NUCLEAR POWER STATION, UNIT 2. Technical Specifications, Proposed Change No. 14. (Commonwealth Edison Co., Chicago, Ill.). 31 Aug 1971. 30p. Dep. NTIS.

Revised technical specifications concerning startup test procedures are presented. The revised specifications provide for a 120% high flux average power range monitoring scram to determine the warranted load response capability of the reactor. (D.C.C.)

53993 (DOCKET-50237-197) DRESDEN NUCLEAR POWER STATION, UNIT 2. Technical Specifications, Proposed Change No. 15. (Commonwealth Edison Co., Chicago, Ill.). 1 Sep 1971. 7p. Dep. NTIS.

Revised technical specifications are presented concerning a substitution of the steam jet air ejector off-gas monitors to perform the monitoring function of the plant chimney monitoring system. This substitution would be effective only during steady state operation and testing. (D.C.C.)

53994 (DOCKET-50237-198) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Technical Specifications, Change Nos. 5 and 13. (Division of Reactor Licensing (AEC), Washington, D. C.). 9 Sep 1971. 14p. (DOCKET-50249-100). Dep. NTIS.

Revised technical specifications are presented concerning the use of respiratory protective equipment for personnel in restricted areas of the reactor site. Protection factors concerning the respiratory equipment are listed. (D.C.C.)

53995 (DOCKET-50249-99) DRESDEN NUCLEAR POWER STATION, UNIT 3. Technical Specifications, Proposed Change No. 6. (Commonwealth Edison Co., Chicago, Ill.). 31 Aug 1971. 30p. Dep. NTIS.

Revised technical specifications concerning startup test procedures are presented. The revised specifications provide for a 120% high flux average power range monitoring scram to determine the warranted load response capability of the reactor. (D.C.C.)

53996 (DOCKET-50271-62) VERMONT YANKEE NUCLEAR POWER STATION. Final Safety Analysis Report, Amendment 30. (Vermont Yankee Nuclear Power Corp., Rutland). 1 Sep 1971. 20p. Dep. NTIS.

Revised and additional data are presented concerning the quality assurance program. (D.C.C.)

53997 (DOCKET-50277-23) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Amendment 10. (Philadelphia Electric Co., Pa.). 8 Sep 1971. 207p. (DOCKET-50278-23). Dep. NTIS.

Proposed technical specifications for the Peach Bottom Power Reactor Units 2 and 3 are presented. (D.C.C.)

53998 (DOCKET-50282-39) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Environmental Monitoring and Ecological Studies Program 1970 Annual Report. (Northern States Power Co., Minneapolis, Minn.). 30 Aug 1971. 398p. (DOCKET-50306-38). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Radiation monitoring data for June to December 1970 are included. (D.C.C.)

53999 (DOCKET-50358-26) WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 19. (Cincinnati Gas and Electric Co., Ohio. Columbus and Southern Ohio Electric Co., Columbus, Ohio. Dayton Power and Light Co., Ohio). 8 Sep 1971. 89p. Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects of the William H. Zimmer Power Reactor Unit 1. (D.C.C.)

54000 (DOCKET-50395-11) VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 1. (South Carolina Electric and Gas Co., Columbia). 27 Aug 1971. 73p. Dep. NTIS.

Requested additional information is presented concerning design parameters and operations aspects of the reactor. (D.C.C.)

54001 (DOCKET-50404-4) NORTH ANNA POWER STATION, UNITS 3 AND 4. Preliminary Safety Analysis Report, Vol. 2. (Virginia Electric and Power Co., Richmond). 15 Sep 1971. 233p. (DOCKET-50405-4). Dep. NTIS.

Information on the North Anna Power Reactor Units 3 and 4 is presented under the following broad topics: coolant system; containment systems; engineered safeguards; and instrumentation and control. (D.C.C.)

54002 (UCLA-ENG-7151) RESPONSE OF SAN ONOFRE NUCLEAR GENERATING STATION TO EARTHQUAKES. Smith, C. B.; Ibanez, P.; Matthiesen, R. B.; Vasudevan, R. (California Univ., Los Angeles. School of Engineering and Applied Science). Jul 1971. 41p.

A series of forced vibration tests at the San Onofre Power Reactor Unit 1 as part of a research program on the response of nuclear reactor systems to earthquakes is described. The intention of the forced vibration tests is to develop a mathematical model of the system. The mathematical model is then used to evaluate the response of the system to earthquake inputs for comparison to actual measured responses to earthquakes. A review of the earthquake activity for the San Onofre Power Reactor Unit 1 site is presented. 9 references. (D.C.C.)

54003 ENVIRONMENTAL CONSIDERATIONS AT NUCLEAR POWER PLANTS. Goldman, Morton I. (Nuclear Utilities Services Corp., Washington, D. C.). pp III.1-23 of Nuclear Power and the Environment. Madison, Wis.; Univ. of Wisconsin (1970).

From Conference on nuclear power and the environment; Madison, Wis. (3 Apr 1970). See CONF-700415.

The basic working principles of nuclear power plants are described. The sources, control, and release of radioactive materials and of heat are discussed and compared to waste effluents from other sources of electric power. (H.D.R.)

54004 RELEASE OF RADIOACTIVITY FROM NUCLEAR INSTALLATIONS DURING ROUTINE OPERATION. Kahn, Bernd (Public Health Service, Washington, D. C.). pp V.1-20 of Nuclear Power and the Environment. Madison, Wis.; Univ. of Wisconsin (1970).

From Conference on nuclear power and the environment; Madison, Wis. (3 Apr 1970). See CONF-700415.

Radiological surveillance results from a study of the Dresden Nuclear Power Station are presented. Radioactivity was measured on-site to obtain the effect of station operation on releases, at the point of release to analyze the constituents of the gross activity, and in the environment where they come in contact with people. Recommendations for improved monitoring of nuclear power station release are summarized. (H.D.R.)

54005 THERMAL EFFECTS OF POWER PLANTS ON ECOLOGY. Mount, Donald I. (Dept. of the Interior, Washington, D. C.). pp IX.1-16 of Nuclear Power and the Environment. Madison, Wis.; Univ. of Wisconsin (1970).

From Conference on nuclear power and the environment; Madison, Wis. (3 Apr 1970). See CONF-700415.

Some of the various definitions people apply to pollution of water are described. Some potential beneficial effects of thermal discharges are discussed. The negative effects of temperature increases on aquatic life are examined in detail. (H.D.R.)

54006 ROLE OF THE PUBLIC IN THE DEVELOPMENT AND REGULATION OF NUCLEAR POWER. Ramey, James T. (Atomic Energy Commission, Washington, D. C.). pp X.1-22 of Nuclear Power and the Environment. Madison, Wis.; Univ. of Wisconsin (1970).

From Conference on nuclear power and the environment; Madison, Wis. (3 Apr 1970). See CONF-700415.

The role of the Atomic Energy Commission in the regulation of nuclear power is examined. The provisions in the AEC regulatory procedures for public participation in both the rulemaking and the licensing processes for nuclear power plants are described. (H.D.R.)

54007 BENEFITS VS. COSTS: THE REAL WORLD. Smith, Stephen C. (Univ. of Wisconsin, Madison). pp XIII.1-4 of Nuclear Power and the Environment. Madison, Wis.; Univ. of Wisconsin (1970).

From Conference on nuclear power and the environment; Madison, Wis. (3 Apr 1970). See CONF-700415.

The need for more thorough investigations into the consequences of technological innovations such as nuclear power is discussed. It is suggested that the concept of environmental economics be added to the benefit-cost evaluations of proposed projects. (H.D.R.)

54008 PROBABILITY TREATMENT OF ATMOSPHERIC DISPERSION FOR DOSE CALCULATIONS. Woodard, Keith (Pickard, Lowe and Associates, Inc., Washington, D. C.). Nucl. Technol.; 12: No. 3, 281-9(Nov 1971).

The atmospheric dispersion characteristics in the vicinity of a nuclear power plant are important in establishing criteria for safety features, reactor containment, and site boundaries so that there is reasonable assurance that radiation dose guidelines would not be exceeded should a major accident occur. Large quantities of meteorological data are available from many sites which provide a good statistical base for evaluating the effect of local site weather conditions on the total dose risk. A model for determining dose level versus probability based on combining time variant weather data with the time variant fission product release following an accident was developed. The results obtained using this model to evaluate several sites indicate that the probability of any individual receiving a dose in excess of regulatory guidelines is quite low, given that an accident has occurred and that the resulting fission product releases are evaluated using conservative AEC licensing assumptions. These results also show a large variation in dose among facilities at a given probability level. Other applications of this model for evaluating doses due to hydrogen purging, for predicting the most favorable time to make routine effluent releases and for assessing total dose risk of a given site are also discussed. (auth)

Power Reactor Development

Refer also to abstracts 53899, 54236, and 54239.

54009 (70-CNA-654) INDUSTRY'S ROLE: A UTILITY VIEW. Morison, W. G. (Hydro-Electric Power Commission of Ontario, Toronto). 1970. 12p. (CONF-700564-14). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970)

Development of the power reactor industry in Canada is reviewed. Arguments for not developing a fuel reprocessing capability are given. (J.M.J.)

54010 (A/CONF.49/P-7) APPROACH TO REGIONAL (NORDIC) CO-OPERATION IN THE NUCLEAR ENERGY FIELD. Marcus, F. R. (Atomic Energy Commission, Helsinki (Finland)). May 1971. 13p. (CONF-710901-62). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

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Work in the nuclear energy field in Denmark, Finland, Norway, and Sweden has been organized in quite different manners to suit the individual needs of each country. The national nuclear energy institutes and their programs in relation to the nuclear power schedules are briefly described. Collaboration was intensified in 1968 through the foundation of the Nordic Coordination Committee for Atomic Energy. Whenever a scheme for practical collaboration between two or more institutes has been worked out, the committee proposes the conclusion of an agreement on this particular item between the institutes involved. In this manner important joint ventures have been carried through, mainly in fields related to reactor technology. These are enumerated and described. Schemes for Nordic cooperation in related fields are also mentioned such as Nordel (the electricity producers' organization), and the collaboration organized around the large-size Swedish nuclear power station Ringhals. Finally, an official collaboration scheme between the four countries has been set up in the field of reactor safety. Its initial aim is to make recommendations for uniform rules concerning reactor licence applications, and to promote, as far as possible, the harmonization of safety criteria. (auth)

54011 (A/CONF.49/P-23) SOME DESIGN AND SAFETY ASPECTS OF GAS BREEDER REACTORS. Gratton, C. P.; Burgsmueller, P.; Chermanne, J.; (and others). May 1971. 17p. (CONF-710901-72). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The design and assessment work carried out on a 1000 MW(e) helium cooled fast reactor is reported. The overall characteristics of this indirect steam cycle plant are described together with the main considerations leading to particular design solutions. Comparisons are made with earlier published work and any important points of difference are discussed. This reference system which uses pin type fuel is the first of two concepts studied. The second concept is based on coated particle fuel and the main features of this alternative are outlined. A review of the safety principles of the reactor design is given and the engineering safeguards specified for the plant are described. Particular emphasis is given to the various aspects of the depressurization fault including the transient behavior of the system. The nuclear characteristics of the reactor are described together with the proposed fuel management scheme. The influence of different nuclear data libraries is examined and the possible uncertainty in breeding performance considered. The fuel technology needed for this reactor is reviewed and comparisons made with the metallurgical conditions suggested for the sodium-cooled fast reactor. The incentive to reach higher clad surface temperatures is considered and the associated economic benefits indicated from the results of optimization calculations are discussed. (auth)

54012 (A/CONF.49/P-106) TRAINING OF PERSONNEL IN RELATION TO THE DEVELOPMENT OF THE NUCLEAR ENERGY PROGRAM IN THE REPUBLIC OF CHINA. Cheng, Chen-Hwa (National Tsing Hua Univ., Hsinchu (Taiwan). Inst. of Nuclear Science). Apr 1971. 13p. (CONF-710901-78). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The steps by which a program was developed for training personnel are described. The first step was the establishment of the Institute of Nuclear Science at National Tsing Hua University. The Institute was part of the graduate school and was to serve the double purpose of training personnel and promoting the application of nuclear energy. Besides courses offered toward the Master of Science Degree in Nuclear Science and Technology, special courses were offered to train personnel in techniques of medical and industrial applications of nuclear energy. Gradually both undergraduate and graduate courses were offered and finally the center withdrew from the academic program altogether to concentrate on the program for practical application of atomic energy. (auth)

54013 (A/CONF.49/P-116) GAS-COOLED FAST BREEDER REACTOR. Fritzsche, A. F.; Lys, L. A.; Sarlos, G. (Swiss Federal Institute for Reactor Research, Wuerenlingen). May 1971. 16p. (CONF-710901-160). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The development of gas-cooled fast breeder reactors is discussed. Design parameters and operation aspects for gas-cooled fast reactors with pin-type fuel elements are described. 7 references. (D.C.C.)

54014 (A/CONF.49/P-127) SURVEY OF AUSTRALIA'S DEMAND AND RESOURCES TO YEAR 2000. McCay, F. L.; Deas, R. D. (Department of National Development, Canberra (Australia)). May 1971. 23p. (CONF-710901-165). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The effects of Australia's geography, population distribution, type of economy and political organization on the energy situation in the country are analyzed. Energy resources are reviewed and statistics are given for historic consumption of the various sources of primary energy. Forecasts are given for future requirements, based on researched data up to the year 1979/80 and on subjective extrapolation beyond this up to the year 2000. A separate section on electricity identifies the features of each of the separate State systems significant in consideration of the prospects for nuclear power in each. The extent and, where available the cost, of known reserves of basic energy resources are given, together with some discussion of the apparent prospects of future significant discoveries. (auth)

54015 (A/CONF.49/P-137) POSSIBILITIES OF INTRODUCING AND INTEGRATING NUCLEAR POWER IN THE UNITED ARAB REPUBLIC POWER SYSTEM. El Koshairy, M. A.; El Guebeily, M. A.; Hamamsy, A.; Effat, K. E.; (and others) (Atomic Energy Establishment, Cairo, Egypt). Jun 1971. 20p. (CONF-710901-352). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Estimates of the new power generation capacity required, and the choice of the type of plants in the U.A.R. are governed to a large extent by comparative economic considerations between the remaining hydro-potential and the construction of thermal stations with the possibilities of integrating nuclear power plants in the grid system. In the light of power system considerations and of comparative economic studies of nuclear power plants with alternative conventional thermal plants, the prospects of integration of nuclear plants in the system are discussed. 10 references. (auth)

54016 (A/CONF.49/P-160) NUCLEAR POWER AND THE ENVIRONMENT. Marko, A. M.; Barry, P. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.); Wilson, R.; Wong, K.; (and others) (Hydro-Electric Power Commission of Ontario, Toronto). May 1971. 12p. (CONF-710901-177). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A modern 1000-MW(e) coal-fired station burns 10,000 tons of coal a day. Coal in storage covers 15 hectares of land to a height of 15 m. Every day the station produces 1,000 tons of slag and fly ash, which in 35 years will cover 40 hectares to a height of 8 m. An equivalent nuclear station requires less than a half a ton of UO_2 per day and in 35 years produces only enough wastes to fill an Olympic-size swimming pool. Nuclear stations cause far less disruption to the landscape than do either hydroelectric stations or fossil-fueled stations. In addition, legislation requires that nuclear stations be operated to very conservative levels of safety, particularly in respect of releases of radioactivity. Canadian experience with prototype nuclear stations indicates that these conservative levels can be met in practice and, as the nuclear power program expands, we are establishing progressively more precise guidelines to ensure that they will be met in the future. A useful concept is a limit of dose to the public expressed in man-Rem per unit of electric power. Nuclear stations currently produce more waste heat than fossil-fueled stations of the same capacity. However, in Canada and other countries with cold climates waste heat may be put to useful purposes. 7 references. (auth)

54017 (A/CONF.49/P-166) GOVERNMENT, UTILITIES, INDUSTRY, AND UNIVERSITIES: PARTNERS FOR NUCLEAR DEVELOPMENT IN CANADA AND ABROAD. Hurst, D. G. (Atomic Energy Control Board, Ottawa (Ontario)); Woolston, John E. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1971. 20p. (CONF-710901-261). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The activities of public, private, and educational institutions in the development and application of nuclear energy in Canada are reviewed. 60 references. (H.D.R.)

54018 (A/CONF.49/P-169) DEVELOPMENT OF NUCLEAR ENERGY AND THE ROLE OF CNEN. Salvetti, Carlo (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1971. 15p. (CONF-710901-85). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

CNEN—The Italian Commission for Nuclear Energy—has outlined its programs considering Italy's economic and industrial potential, as well as all the technological aspects involved. Effort and research have been concentrated in a few special programs which could find the widest common interest both of industries and of ENEL—the Italian Electricity Generating Board. (auth)

54019 (A/CONF.49/P–175) ITALIAN FAST REACTOR PROGRAMME. Fogagnolo, Giorgio (SNAM Progetti S.p.A., Milan (Italy)); Pierantoni, Ferrante (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)). May 1971. 17p. (CONF-710901–184). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The short- and long-term prospects and objectives for the fast reactors development program carried out in Italy by CNEN together with Italian industry are presented. A cost-benefit analysis based on a chosen hypothesis of electronuclear development in Italy over a period of 40 years is described. Particular stress has been given to the part played by fast reactors on the economy of the systems studied and the importance of a correct fuel policy during the years prior to the entry of fast reactors. Account has been taken of the results of the studies of the optimum parameters for the reference commercial plant for which sodium as primary coolant, and UO_2-PuO_2 as fuel, have been chosen. The research and development program, based on the conclusions drawn from this general assessment, is discussed. The principal tool in the fuel element development is the PEC (fuel elements test facility) reactor, the completion of which is expected in 1975, and which forms the main short-term objectives of the Italian Program. Some general considerations about the role that PEC will play in the national and international development of fast reactor fuel are discussed. (auth)

54020 (A/CONF.49/P–176) CIRENE PROJECT. Silvestri, M.; Casagrande, I. (Centro Informazioni Studi Esperienze, Milan (Italy)); Broggiato, A.; (and others) (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). May 1971. 13p. (CONF-710901–87). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The basic design parameters and the economics of the CIRENE heavy-water-moderated boiling-water-cooled reactor concept are presented. (H.D.R.)

54021 (A/CONF.49/P–232) DEVELOPMENT OF PROTOTYPE HEAVY WATER REACTOR (FUGEN) IN JAPAN. Shima, Shiro; Nakata, Seibei; Sawai, Sadamu (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). May 1971. 17p. (CONF-710901–92). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The heavy water-moderated boiling light water-cooled reactor and the construction of its prototype, named FUGEN, are described. One of the main objects of this project is to demonstrate a "plutonium self-sustaining cycle" in which natural uranium enriched with plutonium (recovered from own spent fuel) is to be loaded in the reactor, and the fuel to be supplied will be only natural uranium. At the same time, the reactor is so designed that it could be economically operated not only with slightly enriched uranium oxide fuel, but also with mixed oxide fuel without any modification of the core. FUGEN is designed to generate 165 MW(e), and on-power refueling is considered. (auth)

54022 (A/CONF.49/P–285) STANDARD MODELS OF NUCLEAR PLANTS OF 200 MWe AND 400 MWe FOR DEVELOPING COUNTRIES. Klees, P.; Mommen, E.; Pierard, A. May 1971. 20p. (CONF-710901–105). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The selection of the technical parameters can be guided by an optimization calculation. From its participation to the first PWR's of medium power built in Europe and the progresses realized in the core technology, ACEC developed the parameters of a 200 MW(e) power plant. The core description, the selection of primary equipments and the auxiliary systems are described. The worldwide inventory of small power grids, their growth and interconnection prospects, show that a 200 MW(e) unit size meets the requirements of numerous countries and can be integrated in the investment decisions to be taken henceforth 1975. Considering that the general tendency of doubling in 10 years, the 200 MW(e) unity enables them to take advantage of the nuclear 10 years earlier than the present classical size of 400 MW(e), other things being equal. A 200 MW(e) station in eastern Pakistan is an example. 9 references. (auth)

54023 (A/CONF.49/P–298) PROSPECTS FOR ATOMIC ENERGY DEVELOPMENT IN JAPAN. (Atomic Energy Commission, Tokyo (Japan)). May 1971. 13p. (CONF-710901–107). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Atomic Energy Commission of Japan drew up, in April 1967, a long-range program on the peaceful uses of atomic energy in Japan. The program takes a look into the future shape of the various fields of peaceful uses of atomic energy for about twenty years up to 1985, clarifying the policy for the priority measures for about ten years from fiscal 1967. Based upon this long-range program, national ways to nuclear power generation, the promotion of development of power reactors, procurement of nuclear fuels, construction of Japan's first nuclear ship "MUTSU," promotion of the use of radiation research on nuclear fusion, and finally the safety measures are explained. (auth)

54024 (A/CONF.49/P–333) EDUCATION AND TRAINING IN THE FIELD OF PEACEFUL USES OF ATOMIC ENERGY IN POLAND. Kroh, J. (Technical Univ., Lodz, Poland). May 1971. 11p. (CONF-710901–113). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Polish educational program in the field of atomic energy includes training at secondary schools, universities, post-graduate courses, and PhD studies. The training programs are described. (auth)

54025 (A/CONF.49/P–359) RESOURCES OF PRIMARY ENERGY. Mandel, Heinrich (RWE-Aktiegesellschaft, Essen, Ger.). Apr 1971. 27p. (CONF-710901–123). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Taking the present requirements as a basis, the fossil fuels would be sufficient for about 460 years, the basic materials for nuclear fission even sufficing for 25,000 years. This consideration, however, leads to false conclusions. It is necessary to take into account the world's population growth as well as the increasing per capita consumption. The result is that the reserves of fossil fuels—a constant upward trend to the world's economy in the hitherto known way provided—would, e.g., be sufficient for some more years only towards the end of the 21st century, whereas nuclear fuels would suffice for about 300 years. This means that, on one hand, the world will be dependent upon nuclear fusion at long sight, but that, on the other hand, sufficient time will be left to develop it. (auth)

54026 (A/CONF.49/P–366) BASE PROGRAMME OF THE DeBeNeLux FAST BREEDER PROJECT. Engelmann, P.; Haefele, W. (Kernforschungszentrum, Karlsruhe (West Germany)). Apr 1971. 28p. (CONF-710901–206). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The bases for industrial design work on prototype reactors from 1966 on were led initially in Karlsruhe. Work within the base program was carried through until 1967 in association with Euratom and since 1968 in conjunction with Belgium and Holland. Numerous questions which were open in 1964 could be clarified. The experiments in SNEAK and SEFOR have contributed to improving and ensuring the nuclear design data and safety parameters (Doppler and void effects). The fuel element and material research and the work on coolant technology led in 1969 to the decision to limit the design work on the sodium cooled prototype SNR and to suspend the work on the steam cooled prototype. The intermediate results of work on steam at AEG are reported, while a separate contribution of the industry consortium gives information on the design of the SNR. Here the path is shown that led to the SNR 300 through the design studies Na-1 and Na-2. Conceptual studies for large sodium cooled breeder power plants with oxide and carbide fuel were made during 1969–1970 in order to investigate the influence of the most important design parameters on economy, safety and reactor strategies. They were also allowed to fix the design parameters of the SNR and the future R&D Program. Since plant costs depend on the extent of safety precautions the course of incidents is investigated experimentally and analytically in the base program. This enables a judgement of necessary protective measures (in core instrumentation, core catcher, etc.). The fuel cycle costs depend strongly on the specific power, the burnup and the fabrication costs of the fuel elements. The possibilities of a modern test reactor for the development of fuel elements of all kinds of fast breeders are shown on the example of the preliminary FR3 design. 150 references. (auth)

54027 (A/CONF.49/P–369) FAST BREEDER DEVELOPMENT PROGRAM OF THE CONSORTIUM SNR. Guthmann, Elmar A.; Mante, Alexander J. H.; Morelle, Jean M. (Internationale Atomreaktorbau, G.m.b.H., Bensberg (West Germany). NERATOOM, N. V., The Hague (Netherlands). Societe Belge pour l'Industrie Nucleaire, Brussels). Apr 1971. 20p. (CONF-710901–126). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

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The status of the SNR development program is described, with emphasis on the sodium components testing facilities, the 20 MW(e) KNK reactor, the fuel element development and irradiation testing, and the design of the SNR prototype. 33 references. (H.D.R.)

54028 (A/CONF.49/P–370) TECHNICAL STATUS AND POTENTIAL OF THE HIGH TEMPERATURE REACTOR LINE IN THE FEDERAL REPUBLIC OF GERMANY. Mattick, W. (Brown, Boveri und CIE A. G., Mannheim (West Germany)); Mueller, H.-W. (Brown, Boveri/Krupp Reaktorbau G.m.b.H., Mannheim (West Germany)); Kraemer, H.; Schulten, R. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Apr 1971. 16p. (CONF-710901–127). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The decision for the construction of a 300 MW(e) THTR indicates a progress in realizing high-temperature reactors in the Federal Republic of Germany, due to a successful AVR operation. This project involves all the AVR characteristics as well as all the characteristics of international HTR concepts. Its task is to demonstrate the technical realization of big THTR units and their safe operation. Information is presented on main design characteristics and status of construction and on first results of the R and D construction program which is being performed. This program includes the further development and testing of main equipment, in particular, feed system, absorber rods, fuel elements, prestressed concrete pressure vessel, and core. (auth)

54029 (A/CONF.49/P–480) OBJECTIVES AND REALISATION OF THE HELIUM-COOLED HIGH TEMPERATURE REACTOR. Vaughan, R. D. (Nuclear Power Group Ltd., Knutsford (England)); Insch, G. M. (British Nuclear Design and Construction Ltd., Leicester (England)); Thorn, J. D. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Jun 1971. 12p. (CONF-710901–474). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

What will be expected of reactors built in the next 20 years and the extent to which high temperature reactors should fulfill the requirements is established. The main characteristics of helium cooled reactors in comparison with other systems are given, illustrating features common to the pebble bed, tubular pin and integral brick designs of thermal reactors. The essentials of the helium cooled fast reactor are also mentioned. There is an account of the design trends in high temperature reactors to meet the requirements. There is also an up-to-date report on the experimental work now going forward in the U.K. to support this system when commercial reactors begin to be ordered late in 1971. (auth)

54030 (A/CONF.49/P–481) REVIEW OF THE PROGRESS OF SODIUM-COOLED FAST REACTORS IN THE UNITED KINGDOM. Cartwright, H. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group); Campbell, R. H. (Nuclear Power Group Ltd., Knutsford (England)); Wolff, P. H. W. (British Nuclear Design and Construction Ltd., Leicester, Eng.). May 1971. 8p. (CONF-710901–214). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The construction of the 250 MW(e) Prototype Fast Reactor (P.F.R.) now nearing completion at Dounreay on the north coast of Scotland, the continuing operation of the existing Dounreay Fast Reactor, and the extensive supporting research and development work are all part of a well established and comprehensive program directed towards the early introduction of economic fast reactors in the U.K. as part of a combined fast reactor/thermal reactor nuclear power program. Design studies for large commercial units of 1320 MW(e) gross capacity are an integral part of this work. These design studies which take account of the operational requirements that will be demanded of power stations in the future, together with the work on P.F.R., not only provide data for cost assessment purposes but also highlight the important areas and features to be studied in the development program. The development of the P.F.R. core and core components is described. The design of the early large commercial stations from the P.F.R. design is analyzed. The work in support of fuel transportation, reprocessing and refabrication is described. 6 references. (auth)

54031 (A/CONF.49/P–483) STEAM GENERATING HEAVY WATER REACTOR: A MODULAR REACTOR SYSTEM YIELDING ECONOMIC POWER OVER A WIDE RANGE OF OUTPUT. Brown, G. (British Nuclear Design and Construction Ltd., Whetstone (England)); Moore, J. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group); Smith, D. R. (Nuclear Power Group Ltd., Knutsford (England)). May 1971. 12p. (CONF-710901–288). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The direct cycle Steam Generating Heavy Water Reactor (S.G.H.W.R.) is a pressure tube system permitting a range of outputs to be obtained from standard components manufactured away from the site. Increase in reactor output involves no extrapolation in technology as is the case with pressure vessel systems. The calandria which contains the heavy water moderator and the shield tanks operate at atmospheric pressure only; other reactor plant components are conventional. The system is capable of fast refueling off-load two or three times a year during a two day or week-end shutdown. The pressure tubes provide direct access to each fuel element for withdrawal into the simple fueling machine. Larger reactors involve only a larger number of identical operations. Flexibility in fuel management ensures minimum operating cost to meet operational requirements or unexpected outage. The pressure tube concept permits direct injection of water on to the fuel pins through orifices in a tube which passes down the center of each fuel cluster. This water can be supplied continuously in operation as a part of the feed. Under fault conditions therefore, the fuel is cooled immediately and directly along the entire length of the fuel element. Current S.G.H.W.R. designs are conservatively rated compared with other water reactor systems and may thus be regarded as having considerable development potential. The S.G.H.W.R. is unique in that the parameters currently adopted are fully supported in actual operation on the 100 MW(e) demonstration reactor at Winfrith Heath and by the large 9 MW experimental heat transfer rig on which comprehensive tests have been made. The system is suitable for construction in a range of outputs in those countries without advanced technological resources because of its modular form and high conventional engineering content. 4 references. (auth)

54032 (A/CONF.49/P–504) GRAPHITE AND COOLANT CHEMISTRY OF GAS COOLED THERMAL REACTORS. Wright, J.; Linacre, J. K. (Atomic Energy Research Establishment, Harwell (England)); Dominey, D. A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.); Jaquiss, M. T.; (and others) (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group). May 1971. 13p. (CONF-710901–223). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

After eight years' experience of operating the Windscale Advanced Gas Cooled Reactor, it is possible to compare the chemical behavior of coolant and moderator with that expected from experiments in Materials Test Reactors. The agreement is a measure of the confidence with which the behavior in commercial reactors of this type can be predicted. Graphite weight changes during long periods of steady operation in three different coolant gas compositions are compared with the radiolytic oxidation predicted by C-14 evolution from labeled specimens and from weight changes in Materials Test Reactor experiments. In some coolants a correction must be applied for the carbon deposited in the graphite, a quantity determined by differential thermal oxidation of the sample. This deposition process has been observed and studied in a number of laboratory and Materials Test Reactor experiments. Methane is a constituent of some coolants and is added to inhibit the radiolytic oxidation of graphite. To be effective at the center of large moderator blocks, it must reach that region by diffusion before it is destroyed by radiolysis. Measurements in the Windscale Advanced Gas Cooled Reactor are described which confirm the calculations based on diffusion characteristics of the graphite and on the methane radiolysis rate as determined in Materials Test Reactor and laboratory experiments. These experiments also show that radiation is less effective in destroying methane in gas which is within the graphite pores than in "free" gas some distance from a graphite surface. The total rate of methane destruction in the Windscale Advanced Gas Cooled Reactor is the sum of processes occurring in the two regions. A brief summary is given of the changes in graphite properties which accompany radiolytic oxidation. These are derived from accelerated Material Test Reactor studies because the removal of structural carbon in the Windscale Advanced Gas Cooled Reactor in eight years is so small that no measurable changes have been observed directly. The approach to graphite and coolant chemistry for helium cooled systems is illustrated by examples from the U.K. experimental program for the development of high temperature gas cooled reactors. 41 references. (auth)

54033 (A/CONF.49/P–540) EDUCATION AND TRAINING OF SCIENTISTS AND ENGINEERS IN NUCLEAR TECHNOLOGY. Ramanna, R.; Damodaran, K. K. (Bhabha Atomic Research Centre, Bombay (India)). May 1971. 16p. (CONF-710901–236). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The goals and courses available at the training school of the

Bhabha Atomic Research Center are described. The requirements of developing countries for training programs in nuclear science and engineering are discussed. (H.D.R.)

54034 (A/CONF.49/P-541) EXPERIENCES GAINED IN CZECHOSLOVAKIA WITH CONSTRUCTION OF NUCLEAR POWER. Neumann, J.; Barabas, K. (Czechoslovak Atomic Energy Commission, Prague). Jun 1971. 16p. (CONF-710901-475). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

54035 (A/CONF.49/P-569) DEVELOPMENT OF THE NUCLEAR PROGRAM OF ELECTRICITE DE FRANCE. Hannothiaux, A. (Electricite de France, Paris). May 1971. 12p. (In French). (CONF-710901-243). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Electricité de France has started a large experimental nuclear program within the natural uranium, graphite, CO_2 layout. When the Saint-Laurent-des-eaux plant was put into service and proved that the selected layout was technically satisfactory, considerations of essentially economic nature brought Electricité de France, in agreement with the Public Authorities, to "diversify" its nuclear program and, while waiting for the realization of industrial breeders, to mainly engage itself towards enriched uranium reactors, moderated by water. (auth)

54036 (A/CONF.49/P-583) PRESENT STATUS AND PREDICTED DEVELOPMENT OF FAST BREEDER IN FRANCE. Vendryes, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Denielou, G. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires); Faure, J. (Electricite de France, Chatou); Payan, G.; (and others) (Societe Creusot-Loire, Paris (France)). Jul 1971. 16p. (CONF-710901-441). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

54037 (A/CONF.49/P-585) WORK DONE IN FRANCE ON HIGH-TEMPERATURE REACTORS. Tanguy, P.; Loriers, H.; Maillet, E. (Commissariat a l'Energie Atomique, Saclay (France). Nuclear Research Centre); Buisson, A.; (and others) (French Industrial Group for High-Temperature Reactors). Jun 1971. 17p. (CONF-710901-400). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Based on the experience gained in France on natural uranium fueled–graphite moderated–gas cooled reactors, an extensive program of research and development has been started both in CEA and in industry. French work is taking advantage of the various facilities developed for the gas-graphite program, both for out-of-pile tests and for irradiation experiments, with the CEA reactors Osiris, Pegase, Siloe and Rapsodie. The emphasis is put mainly on the following: 1. fuel development and irradiation, starting with coated particles and compacts (with investigations on a new compacting process by gas carbon cracking) and extending to tests of complete fuel elements of the tubular interacting type; 2. graphite, with studies on irradiation behavior of various types, and research on stability of graphite core structures under seismic conditions; 3. various tests in helium atmosphere: seals, thermal insulation, refractory materials, and steels; and 4. reactor physics using critical facilities Marius (room temperature) and Cesar (400°C). (auth)

54038 (A/CONF.49/P-693) DEVELOPMENT OF NUCLEAR POWER STATIONS WITH WATER MODERATED AND WATER-COOLED REACTORS IN THE SOVIET UNION. Denisov, W. P.; Markov, Y. W.; Sidorenko, W. A.; Skwortzov, S. A.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 33p. (CONF-710901-415). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The experience in operation and development of the new nuclear power plant projects with the water-moderated water-cooled reactors has shown that the possibilities of their improvement are far from being exhausted. The ways of simplification of and improvements in the individual members, assemblies, schematic and operational solutions are shown in the report for the development of a nuclear power plant with the VVEhR-1000 reactor. A special attention is paid to the problems of increasing the equipment reliability and nuclear power plant safety. In conclusion an attempt is made to generalize the experience gained in projecting and operation of the nuclear power plants with water-moderated water-cooled reactors and the ways of their further improvements. 6 references. (auth)

54039 (A/CONF.49/P-712) PROSPECTS OF DEVELOPMENT OF NUCLEAR POWER INDUSTRY IN THE USSR. Petrosyants, A. M.; Alexandrov, A. P.; Dollezhal, N. A.; Leipunskii, A. I. (State Atomic Energy Committee, USSR). Aug 1971. 25p. (CONF-710901-498). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

54040 (A/CONF.49/P-738) DEVELOPMENT OF HIGH TEMPERATURE REACTOR TECHNOLOGY IN THE DRAGON PROJECT. Shepherd, L. R. (Atomic Energy Establishment, Winfrith (England)). Apr 1971. 14p. (CONF-710901-325). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The development and status of the Dragon Project helium cooled high temperature reactor are briefly outlined. (H.D.R.)

54041 (A/CONF.49/P-796) JCEA PLANS FOR THE DEVELOPMENT OF NUCLEAR SCIENCE AND TECHNOLOGY IN PERU. (Junta de Control de Energia Atomica, Lima (Peru)). Apr 1971. 10p. (In Spanish). (CONF-710901-333). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In order to cope with growing energy needs, JCEA, with the approval and support of the Peruvian Government, has drawn up a plan consisting of two basic programs to be implemented simultaneously: (1) the training of scientific and technical personnel at home and abroad in specific aspects of the most urgent problems facing the country; and (2) the construction, over a period of six years, of a nuclear center with functional facilities suitable for study and research. (auth)

54042 (A/CONF.49/P-818) FORECASTS OF ITALY'S ENERGY REQUIREMENTS UP TO THE YEAR 1990 AND ROLE OF NUCLEAR ENERGY. Angelini, Arnaldo M. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)); Marinone, Franco May 1971. 18p. (CONF-710901-340). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The growth of power demand related to the individual sources of energy in Italy in the past fifteen years is analyzed. The main problems associated with the energy situation in the country, particularly as concerns reliability and economy of fuel procurement, are discussed. Based on this analysis and on the anticipated development of Italy's economy, predictions of the energy demand up to the year 1990 are made and a brief discussion follows on the contribution that each primary source will be able to make to cover the demand, in the light of the domestic energy resources, the foreseeable trend of the world fuel market, and the anticipated technical and economic evolution of the processes applied for the transformation and utilization of the sources. The past history of the Italian electric power system is reviewed. The electric energy and power requirements are predicted to the year 1990. The potential for development of hydroelectric, geothermal and pumped-storage stations is considered, as well as the role that nuclear energy may be called upon to play in order to meet the increased requirements. Factors involved in the development of nuclear power plants are analyzed. 3 references. (auth)

54043 (A/CONF.49/P-819) PROGRAM AND THE PRESENT STATUS OF FAST BREEDER REACTOR DEVELOPMENT IN JAPAN. Oyama, A.; Ichino, I.; Miki, R.; Mochizuki, K. (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)). May 1971. 16p. (CONF-710901-341). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The development of fast breeder reactors is discussed. Two sodium-cooled fast reactors, using mixed oxide fuel, will be constructed within 10 years. One reactor is the experimental fast reactor named "Joyo," with a designed power of 100 MW(t), intended to give the necessary technological experience for developing a prototype reactor, and also to serve as an irradiation facility for fuel and other materials. "Joyo" is now under construction, with criticality set for in 1974. The other project is the prototype fast breeder reactor named "Monju," for generating electric power of about 300 MW(e). Conceptual design is now under way, in collaboration with Japanese industrial companies. The loop type with a single rotating plug, with fixed arm fuel handling mechanism, was selected for the design. The sum of about $108 million will be invested by the end of 1971 FY in construction and associated research and development. 15 references. (auth)

54044 (A/CONF.49/P-852) DEVELOPMENT AND POWER TESTS OF THE THERMIONIC REACTOR-CONVERTER "TOPAZ". Gryaznov, G. M.; Eltsov, A. I.; Kuznetsov, V. A.; Malykh,

V. A.; (and others) (State Committee for Atomic Energy, USSR). Sep 1971. 20p. (CONF-710901-513). Dep. NTIS (U.S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Thermionic reactor "Topaz" start-up was carried out in the USSR in 1970. This reactor-converter steadily generated electric power of 5-10 kW during more than 1000 hours depending on operating conditions. Design parameters and test results are given. (auth)

54045 NUCLEAR PLANT. **Isberg, Per Gustaf; Sundqvist, Cnut Herbert; Pind, C. W. (to Allmanna Svenska Elektriska Aktiebolaget). French Patent 2,004,986. 5 Dec 1969. Priority date 28 Mar 1968, Sweden. (In French).**

A nuclear power plant is described containing a nuclear reactor provided with a reactor vessel under pressure, a primary system containing this reactor vessel, a circuit under pressure connected to the vessel and containing the coolant, and a primary sealed enclosure with a lateral wall. This primary sealed enclosure surrounds the reactor and a part of the primary system. A secondary sealed enclosure surrounds the primary enclosure and is a rock chamber. (J.S.R.)

54046 INITIATIVES FOR THE FUTURE OF ENERGY. **David, Edward E. Jr. Proc. Nat. Acad. Sci. U. S. A.; 68: No. 8, 1920-2(Aug 1971).**

Predicted growth of energy demands in the U. S. is described. Comparison of all power sources including nuclear power is presented. Proposed development plans for power reactors in the U. S. are outlined. (D.C.C.)

54047 ELECTRIC POWER FROM NUCLEAR FISSION. **Benedict, Manson (Massachusetts Inst. of Tech., Cambridge). Proc. Nat. Acad. Sci. U. S. A.; 68: No. 8, 1923-30(Aug 1971).**

The types of power reactors used in the U. S. are described. The advantages, deficiencies, and problems with the present generation of reactors are analyzed. Proposed development plans for future U. S. power reactors are presented. 6 references. (D.C.C.)

54048 ROLE OF NUCLEAR POWER IN FILLING THOSE NEEDS. **Hubbert, M. King (Geological Survey, Washington, D. C.). pp II.1-36 of Nuclear Power and the Environment. Madison, Wis.; Univ. of Wisconsin (1970).**

From Conference on nuclear power and the environment; Madison, Wis. (3 Apr 1970). See CONF-700415.

A comprehensive view of the world's energy resources appropriate for large-scale industrial power production is presented. The entire energy budget of the world as of a given time and the changes of the energy budget as a function of human energy uses are examined. The potential effects on human development of utilization of fossil, solar, and nuclear energy resources at various rates are discussed. (H.D.R.)

54049 TEMPERATURE MONITORS FOR UNINSTRUMENTED IRRADIATION EXPERIMENTS. **Bramman, J. I. (United Kingdom Atomic Energy Authority, Caithness, Scotland); Fraser, A. S.; Martin, W. H. J. Nucl. Energy; 25: No. 6, 223-40(Jun 1971).**

The construction, use of and the interpretation of data from temperature monitors developed for incorporation in uninstrumented irradiation facilities are surveyed. Depending on the choice of monitor, it is shown that maximum, mean, or end-of-run irradiation temperatures in positions inaccessible to thermocouple leads can be estimated with acceptable accuracy for most practical purposes. (auth) (UK)

54050 STRUCTURAL MECHANICS IN REACTOR TECHNOLOGY. VOL. 1. REACTOR CORE. PART D. FUEL ELEMENTS. **Preprints of the First International Conference, Berlin, Germany, 20–24 September 1971. Jaeger, Thomas A. (comp.). Luxemburg; Commision of the European Communities (1971). 200p. (In German and English). (CONF-710903–(Vol.1)(Pt.D)).**

Included are papers on stress analysis for nuclear reactor fuel elements and graphite core components. Specific topics discussed include: (1) Response of a tightly clustered nuclear fuel element bundle to arbitrary initial thermal and mechanical loading conditions; (2) Stress analysis of a bimetallic cylindrical joint; (3) Finite element analysis of stresses in fuel elements of a high-temperature gas-cooled reactor; (4) Thermal stresses in a circular cylinder with a rectangular hole under heat generation; (5) Elastic-plastic theory for artificial graphite; (6) Anisotropic, elastic-plastic-thermal stress analyses of solid structures; (7) Three dimensional transient thermoelastic stresses in constrained spherical fuel elements; (8) Stresses in spherical fuel elements of a HTR; (9) Stresses in the graphite structures of the THTR prototype; and (10) Core wall and bottom stresses in a pebble bed reactor during control rod insertion. (H.D.R.)

54051 STRUCTURAL MECHANICS IN REACTOR TECHNOLOGY. VOL. 2. REACTOR COMPONENTS. PART E. SHOCK AND VIBRATION ANALYSIS OF REACTOR COMPONENTS. **Preprints of the First International Conference, Berlin, Germany, 20–24 September 1971. Jaeger, Thomas A. (comp.). Luxemburg; Commission of the European Communities (1971). 318p. (In German and English). (CONF-710903–(Vol.2)(Pt.E)).**

Papers presented on methods for analysis of shock and vibration in reactor core and structural components include: (1) Viscous damping of rapidly heated reactor fuel rods; (2) Influence of finite duration pressure pulses on transient response of cylindrical and spherical shells; (3) Stress on fuel element boxes through sodium boiling and condensation impact; (4) Transient response of linear elastic structures; (5) Impact stress waves in composite structures; (6) Pressure vessel loading due to a channel rupture in a pressure tube reactor; (7) Eulerian study of propagation of fast reactor excursions; (8) Reliability of computer predictions of the hydrodynamics of reactor excursions; (9) Dynamic response of reactor containment to high-energy excursions; (10) Energy absorption by the concrete biological shield under shock loading; (11) Dynamic response of a structure subjected to explosive loading; (12) Vibration behavior of fast breeder fuel elements; (13) Self-sustained vibration of rods in parallel flow; (14) Response of a cylindrical cantilever to axial air water flow; (15) Vibration of reactor internals; (16) Vibrations induced by two phase (gas-liquid) coolant flow in pressure tube reactors; and (17) Reactor engineering effects as sources of stochastic noise in neutron reaction rates. (H.D.R.)

54052 STRUCTURAL MECHANICS IN REACTOR TECHNOLOGY. VOL. 2. REACTOR COMPONENTS. PART F. STRUCTURAL ANALYSIS OF CORE SUPPORT AND COOLANT CIRCUIT STRUCTURES. **Preprints of the First International Conference, Berlin, Germany, 20–24 September 1971. Jaeger, Thomas A. (comp.). Luxemburg; Commission of the European Communities (1971). 385p. (In several languages). (CONF-710903–(Vol.2)(Pt.F)).**

Papers presented on methods for the analysis of static and dynamic stresses in reactor components include: (1) Reactor internals response under a blowdown accident; (2) Stresses and fatigue strength of a bolted core support structure; (3) Design analysis for LMFBR core restraints; (4) Optimization of a reactor vessel internal support flange; (5) Dynamic analysis of a reactor head plate design; (6) Lateral deformations of coupled tubular structures; (7) Design of FR-3 reactor coolant loop tubes; (8) Elastic stability of hexagonal shells; (9) Elastic instability of edge-reinforced annular plates; (10) Stresses in a circular disk containing a pair of holes; (11) STRAP code for the static and dynamic analysis of reactor structural systems; (12) Dynamic analysis of nuclear equipment supports; (13) Plastic strain in heat exchanger tubesheets; (14) Analysis of pipework systems under creep conditions; (15) Design of expansion bellows using the collocation method; (16) Limit pressure of branch-pipe tee connections; (17) Stress analysis of a steam generator head; (18) Stress analysis of the hot box pressure dome and skirt for the Hartlepool reactor pressure vessels; (19) Acoustic stress in gas coolant circuit components; (20) Stress analysis of piping tee joints; (21) Stress analysis of coolant circulation pumps; and (22) Design of PWR coolant system support structures. (H.D.R.)

54053 STRUCTURAL MECHANICS IN REACTOR TECHNOLOGY. VOL. 3. REACTOR PRESSURE VESSELS. PART G. STEEL PRESSURE VESSELS. **Preprints of the First International Conference, Berlin, Germany, 20–24 September 1971. Jaeger, Thomas A. (ed.). Luxemburg; Commission of the European Communities (1971). 374p. (In German and English). (CONF-710903–(Vol.3)(Pt.G)).**

Included are 22 papers on stress analysis methods for steel pressure vessels. Topics discussed are: stresses at nozzle to shell junctions; flange (bolted closure) design; materials properties and radiation effects on fracture mechanics; stress relief cracking in welds; acoustic emission analysis of crack propagation; and surface crack detection. (H.D.R.)

54054 STRUCTURAL MECHANICS IN REACTOR TECHNOLOGY. VOL. 4. REACTOR PLANT STRUCTURES AND CONTAINMENT. PART J. ANALYSIS OF SHELL STRUCTURES; CONTAINMENT. **Preprints of the First International Conference, Berlin, Germany, 20–24 September 1971. Jaeger, Thomas A. (comp.). Luxemburg; Commission of the European Communities (1971). 222p. (In German and English). (CONF-710903–(Vol.4)(Pt.J)).**

Papers on stress analysis in reactor containment shells include: (1) Stress analysis in shells of revolution; (2) Curved finite element analysis of shells; (3) Loading of circular cylindrical shells; (4) Finite element analysis of anisotropic viscoelastoplastic shells;

(5) Elastic-plastic analysis of shells of revolution; (6) Large deflections of viscoelastic orthotropic cylindrical shells; (7) Finite element analysis of containment vessels; (8) Thermal gradient effects in containment vessel walls; (9) Dynamic analysis of prestressed concrete vessels; (10) Loading response of prestressed concrete containment structures; and (11) Structural analysis of Rajasthan and Madras power reactor containment structures. (H.D.R.)

54055 STRUCTURAL MECHANICS IN REACTOR TECHNOLOGY. VOL. 5. STRUCTURAL ANALYSIS AND DESIGN. PART L. THERMAL AND MECHANICAL ANALYSIS. Preprints of the First International Conference, Berlin, Germany, 20–24 September 1971. Jaeger, Thomas A. (comp.). Luxemburg; Commission of the European Communities (1971). 538p. (In several languages). (CONF-710903-(Vol.5)(Pt.L)).

Papers are presented on techniques used for thermal and mechanical analyses of reactor components and structures. Discussions are included on: heat conduction; deformation; temperature distribution; creep; mechanical and thermal loading; stress limits; application of finite element methods; strain cycling; fatigue strength; fracture mechanics; and radiation effects. (H.D.R.)

54056 STRUCTURAL MECHANICS IN REACTOR TECHNOLOGY. VOL. 5. STRUCTURAL ANALYSIS AND DESIGN. PART M. DESIGN, RELIABILITY, COMPUTATION METHODS. Preprints of the First International Conference, Berlin, Germany, 20–24 September 1971. Jaeger, Thomas A. (comp.). Luxemburg; Commission of the European Communities (1971). 419p. (In several languages). (CONF-710903-(Vol.5)(Pt.M)).

Papers are presented on methods for design and stress analysis of reactor components and systems. The analytical methods discussed include: reliability and probability analyses; finite element techniques; orthogonal projection in the Hilbert space; and analytic continuation. (H.D.R.)

54057 IMPROVEMENTS IN AND RELATING TO CIRCULATION OF CORE ELEMENTS IN PEBBLE-BED REACTOR. Rausch, William; Von der Decken, C. D.; Huhndorf-Richter, B. (to Brown Boveri/Krupp Reaktorbau, GmbH). Australian Patent 290,347. 21 Apr 1969. Priority date 12 Sep 1964, Germany.

A description is given of the shaping of the inside wall of a pebble-bed reactor core vessel in such a way as to prevent creation of an ordered structure in the marginal zones. The inside wall of the vessel is predominantly cylindrical and the axis of the cylinder is parallel to the direction of movement of the core elements. These elements may be circulated by means of a device in which core vessel guide surfaces preventing creation of an ordered element structure in the marginal zones are arranged. The arrangement consists of at least 2 rows acutely angled to the cylinder axis and located around the periphery of the inside wall. The guides formed create a boundary surface for the pebble-bed, and have a quasi-conical development. (Australia)

54058 NUCLEAR REACTORS. Velez O, C. Rev. Mex. Fis.; 19: FA41-50(1970). (In Spanish).

A brief review is given of the history of the studies of reactors in Mexico, reactor theory, present status, achievements in the field of reactors and the perspectives of reactor construction in Mexico. 42 references. (R.V.J.)

54059 TASKS OF THE PHYSICIST IN MASTERING POWER-GENERATING NUCLEAR REACTORS. Adam, E.; Collatz, S.; Falkenberg, D.; (and others). (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 13: 310-16(Oct 1970). (In German).

The role of physicists within the framework of nuclear power stations is discussed. Covered are: behavior of material under intensive ionizing radiation, physical problems within the core, computer methods for reactor physics, measuring techniques for control of reactor operation, control of burnup and content of fissionable material, measurements for radiation protection, instrumentation and automatization of reactors. (H.B.G.)

Kinetics and Dynamics

54060 (AI-AEC-13005) LMFBR PHYSICS PROGRAMS. Annual Technical Progress Report, GFY 1971. (Atomics International, Canoga Park, Calif.). 15 Aug 1971. Contracts AT-(04-3)-701; AT(04-3)-824. 85p. Dep. NTIS.

BORON— reactivity worth in fast reactor cores, specific, (E/T)
BORON-10— reactivity worth in fast reactor cores, specific, (E/T)
CRITICAL ASSEMBLIES—physics parameters of ZPR-3 and ZPPR-2 benchmark cores, (E/T)
—cores for ECEL, configuration and reactivity worth measurements in
—neutron flux spectra in ECEL cores, (E/T)
EUROPIUM— reactivity worth in fast reactor cores, specific, (E/T)
GRAPHITE—neutron slowing down density distribution in, evaluation of ENDF/B data for, (E/T)
LIQUID METAL FAST BREEDER REACTOR—physics measurement programs during July 1970 to June 1971
NEUTRON CROSS SECTIONS—calculations for fast assemblies, evaluation of ENDF/B data for, (E/T)
PLUTONIUM 239—neutron fission cross section for, evaluation of ENDF/B data for, (E/T)
—neutron fission rate in ECEL core 20, effects of axial position on, (E)
REACTOR CONTROL ELEMENTS—heating rates in mockup tantalum, in fast cores, (E/T)
—reactivity worth of mockup tantalum, in fast cores, (E)
REACTORS, FAST—physics calculations for, development of RABBLE and VIM codes for
TANTALUM— reactivity worth in fast reactor cores, specific, (E/T)
TANTALUM 181—neutron capture cross sections for, evaluation of data for calculation of, (E/T)
URANIUM 235—neutron fission rate in ECEL core 20, effects of axial position on, (E)
URANIUM 238—neutron fission rate in ECEL core 20, effects of axial position on, (E)
WATER—neutron slowing down density distribution in, evaluation of ENDF/B data for, (E/T)
WATER-d_2—neutron slowing down density distribution in, evaluation of ENDF/B data for, (E/T) (H.D.R.)

54061 DOPPLER TEMPERATURE COEFFICIENTS OF FAST REACTORS. Nakamura, Kunihiko (Kyoto Univ., Uji, Japan). Nippon Genshiryoku Gakkai Rochuseishi Kenkyu Senmon Iinkai Hokoku; No. 21, 1-5(Mar 1969). (In Japanese).

A method to calculate Doppler temperature coefficients is presented. A new formula was derived, which is useful for the intermediate region between separable and nonseparable regions of resonance. The overlapping effect of resonances is discussed. Three cases are considered: the overlapping of resonances which belong to the same series of the same nuclide; the overlapping of resonances which belong to the different series of the same nuclide; and the overlapping of resonances which belong to different nuclides. A method was used in which X^2 distribution is assumed for nuclear constants and the average values are taken by weighting the distribution function. The calculated temperature dependency of the effective cross-section of ^{235}U is shown. Numerical calculation was also performed for the homogeneously mixed system of ^{235}U and ^{238}U, and the result is shown in figures. It was concluded as the result of calculation that the effect of overlapping is not so large, and the part of overlapping correction factor for ^{235}U is a little larger in case of $N_{235}/N_{238} = 1$. The effect of overlapping of the resonances belonging to different series can be neglected when the Doppler reactivity effect is considered. (Japan)

54062 EFFECT OF A METALLURGICAL PHASE CHANGE IN FUEL ON THE POWER COEFFICIENT OF EBR-II. Long, John K. (Argonne National Lab., Idaho Falls, Idaho). Nucl. Technol.; 10: No. 1, 17-21(Jan 1971).

Except for irradiation experiments, EBR-II is fueled with a metal alloy of U and fission products called fissium. At room temperature and up to 550°C the metallurgical phase of the fuel corresponds to the phase designated as α-uranium. Recent operations with EBR-II up to 62.5 MW have raised some fuel temperatures to levels at which the metal fuel undergoes a phase change from the α phase to the γ phase. The γ phase of fissium has a significantly lower density, which is reflected in the calculated power coefficient of the reactor. A calculation of the internal fuel temperature, taking into account the variation of thermal conductivity with irradiation-induced swelling, has led to a calculated effect of the γ phase on the power coefficient. This calculated effect agrees with observations during reactor operation. (8 references) (auth)

54063 SPATIAL BEHAVIOR OF NEUTRON FLUX DURING POWER REACTOR TRANSIENTS AS EFFECTED BY THE XENON-IODINE CHAIN. Sumpter, James Robert. College Station, Tex.; Texas A and M Univ. (1970). 303p. University Microfilms Order No. 71-17,841.

Thesis.

A study was undertaken of the characteristics of spatial neutron flux variations, induced by the xenon-iodine chain, occurring during power reactor transient behavior. Using the physical model of a uniform ring reactor, and the mathematical techniques of pertur-

XUM

bation theory and modal analysis, azimuthal oscillatory variations in power were examined as a function of the design and operating parameters of a nuclear power plant system. The types of transient behavior studied included power startups and power decreases of a step and ramp function form. The nature of the resulting xenon-induced spatial power oscillations was discovered to be quite unique when compared to their counterparts occurring during steady-state operation. Their behavior was affected by the time during a power level change when they were initially induced and the rate of the power level change. Distinct initial power-tilts also appeared in their behavior that were relatively short in duration and occurred within a few hours after the completion of the power level change. These were most prominent in reactors of large size operated at relatively high equilibrium thermal neutron flux levels or high power densities. The power-tilts were conspicuous even in asymptotically stable systems and therefore presented a serious control problem. The presence of various temperature feedback coefficients was found to cause a significant reduction in the magnitude of the oscillations, and in fact, was found to be necessary to maintain reactor stability in the cores being presently designed. Various methods of remedial control through the use of a soluble chemical poison were studied, and it was found that with proper procedures, xenon-induced spatial flux oscillations occurring during power reactor transients could be safely controlled without sacrificing the power capability of the core. (Diss. Abstr. Int., B)

54064 SEFOR MINIMUM CRITICAL CORE. Noble, L. D.; Greebler, P.; Pflasterer, G. R. Jr.; Sarma, B. U. B.; Wintzer, D. (General Electric Co., Sunnyvale, Calif.). Nucl. Technol.; 10: No. 1, 5-10(Jan 1971).

The minimum critical core size for the Southwest Experimental Fast Oxide Reactor (SEFOR) was predicted prior to the initial fuel loading using the results of a critical mockup in ZPR-III. The predicted minimum critical loading was 519 PuO_2-UO_2 fuel rods containing 285 kg of fissile ($^{239}Pu + ^{241}Pu$) plutonium, with one beryllium oxide tightener rod for each six fuel rods. The actual minimum critical loading was equivalent to a core containing 518 standard fuel rods and the nominal 6-to-1 ratio of fuel-to-tightener rods. The calculations used in the prediction are described and the agreement between experiment and calculation is discussed. (23 references) (auth)

Control Systems

Refer also to abstracts 51948, 53893, and 54098.

54065 NUCLEAR REACTORS. Martin, Dudley James Victor (to United Kingdom Atomic Energy Authority). British Patent 1,233,832. 3 Jun 1971. Filed 9 May 1969.

Reference is made to means of flux shaping and control of heterogeneous reactors. By flux shaping is meant depression of higher intensity regions to achieve a substantially uniform intensity across the core. Conventional means for achieving this consist of introducing neutron absorbing material into selected regions of the core and removing it progressively as burn-up proceeds; such means usually require additional structure by way of guides or ducts in the core, involving an economic penalty. In the system described the absorbing material is contained in structures already provided for another purpose, thereby reducing the requirement for additional structural material. The absorbing material is located within fuel assemblies and there is access to the material while the fuel assemblies are in their operating position, without breaching the coolant circuit. With cluster type fuel assemblies a thimble tube, such as is provided for a flux scanning wire, may be provided for containing the absorbing material. The latter may be Kr or Xe gas, ducted to the thimble tube from control equipment, the gas being pressurised to vary its density and thereby its neutron absorption. The material may also be liquid or solid, contained in a replaceable capsule contained in the thimble tube. (UK)

54066 GAS-COOLED NUCLEAR REACTORS. Walker, Alexander (to British Nuclear Design and Construction Ltd.). British Patent 1,234,568. 3 Jun 1971. Filed 3 Jul 1967.

Reference is made to reactors having multiple access standpipes through the top of the pressure vessel. In such a reactor undesirably thin webs of material may be left between the standpipes. In the design described each control rod standpipe is of just sufficient size to accommodate the control rod flexible support member, and a further aligned standpipe for each control rod channel is provided in the bottom of the pressure vessel, normally closed by a plug, and of sufficient size to permit the control rod to pass through. The closure plug may be provided with a control rod shock absorber. (UK)

54067 CONTROL DEVICE FOR PEBBLE-BED NUCLEAR REACTORS. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,236,330. 23 Jun 1971. Priority date 20 Dec 1968, Germany.

REACTOR CONTROL ELEMENTS—design parameters of helical grooved rod type, for pebble bed reactors
—drives for helical grooved rod type, description of coaxial shaft threaded gear
REACTORS, PEBBLE-BED—control rods for, description of helical grooved
—control rod drives for, description of coaxial shaft threaded gear (D.C.C.)

54068 SAFETY DEVICE FOR NUCLEAR REACTORS WITH MEANS FOR PREVENTING CONTROL ROD EJECTION. Handel, Karlheinz (to Gesellschaft fuer Keinforschung mbH). U. S. Patent 3,580,805. 25 May 1971. Priority date 8 Nov 1966, Germany.

A safety device for nuclear reactors is described wherein the reactor comprises a housing or containment surrounding a core having moveable control rods therein and a pressure tube extending from the housing in which the control rod and the control rod movement mechanisms are contained or to which they are attached. A safety locking device is provided within the housing which comprises pawl means proximate to mating-engagement means extending from the control rod. The pawl is held away from the extended engagement means under tension. In the event that the pressure tube is forced away from the reactor, the means holding the pawl away from the extended engagement means is removed, whereby permitting the pawl to engage the engagement means and prevent the ejection from the core of the control rod. (auth)

54069 METHOD AND APPARATUS FOR CONTINUOUS MONITORING AND CONTROL OF NEUTRON ABSORPTION PROPERTIES OF CHEMICAL SHIM. Johnson, Loering M.; Yuile, Arthur M. (Combustion Engineering Inc.). U. S. Patent 3,578,562. 11 May 1971. Filed 23 Oct 1968.

An apparatus is described to continuously monitor and control the neutron absorption properties of chemical shim used in regulating reactivity of a pressurized water nuclear reactor. Coolant-moderator fluid, including the soluble neutron absorption property in the chemical shim, is continuously passed through a chamber having plural neutron detectors surrounding a neutron source of known strength. Utilizing the neutron absorptiometry principle, a signal representative of the concentration of the absorption properties of the chemical shim in the coolant-moderator is derived. This signal is then applied through signal conditioning means to a readout and alarm device so that constant monitoring of the shim concentration absorption properties may be accomplished; additionally, the signal may be applied to maintain the concentration of neutron absorption properties of the chemical shim in the coolant-moderator at a desired level. (auth)

Cooling Systems

Refer also to abstracts 51677 and 51873.

54070 (A/CONF.49/P-307) NORDIC STUDIES ON PRESTRESSED CONCRETE PRESSURE VESSELS FOR WATER REACTORS. Margen, P. H. (Aktiebolaget Atomenergi, Studsvik (Sweden)); Ferd, G. (Institutt for Atomenergi, Kjeller (Norway)); Haga, I. (ASEA-ATOM, Vasteras (Sweden)); Jensen, A.; (and others) (Danish Atomic Energy Commission, Risoe. Research Establishment). May 1971. 17p. (CONF-710901-201). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A survey of Nordic efforts on development of prestressed concrete pressure vessels for water reactors is presented. A joint project study of an 800 MW(e) BWR-plant with concrete pressure vessel is presented. The vessel is designed for normal operation at 70 bars, and equipped with a full-diameter, removable top closure and a special insulation system. Internal dimensions are 7 m diameter × 17 m height. Design features, safety characteristics, and economy are described and comparisons made with a conventional BWR-plant with steel pressure vessel. Another joint Nordic activity was the design, construction and testing of a 1 : 3, 5 scale model of the BWR vessel. The model was thoroughly instrumented with ~1000 gauges. The structural response of the vessel has been investigated in the elastic region up to 1.5 × design pressure, creep rates were measured under realistic operating conditions and valuable information was gained on the behavior under overload and transient conditions. The feasibility of the top closure design even after sustained overload operation was demonstrated. The insulation system has been tested both under steady state conditions (max. 85 bar, 298°C hot-side temperature) and under transient conditions involving rapid depressurization of the vessel. The insulation was tested both with N_2-gas and water as filling medium. Some of the basic research activities are described. Among these a series of model vessel experiments, carried out by the Technical University of Norway, and Danish concrete irradiation experiments are mentioned. 22 references. (auth)

54071 (A/CONF.49/P-482) DEVELOPMENT AND MANUFACTURE OF SOME IMPORTANT COMPONENTS FOR THE PROTOTYPE FAST REACTOR AT DOUNREAY. **Bowles, L. F.; Hastwell, B. T.; Lockney, E. V.; Oliver, K. E.; (and others)** (Babcock and Wilcox Ltd., London (England)). May 1971. 11p. (CONF-710901-215). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The aspects described are mainly those which stem from their application to Na systems and include such subjects as development, materials selection and quality assurance. The burst pin detection system, which detects and locates leaking fuel pins, includes high temperature electromagnetic pumps and a rotating selector valve. The techniques used during the development, manufacture and inspection of this system are described. The diagrid supports the reactor core, ducts Na coolant to the fuel carriers and must be fabricated with dimensional accuracy and high integrity welds. For this component, and some of the larger Na valves, the methods adopted for overcoming weld distortion, for welding in highly constrained conditions, and for heat treatment are presented. The stainless steel reactor jacket is a hot Na duct of unusual geometry. Its manufacture is described. Its insulation system is required to minimize temperature degradation of the Na coolant being delivered to the intermediate heat exchangers and to protect it from thermal stress and shock. The insulation, together with the welding and nondestructive testing techniques developed and used, are discussed. The modifications introduced in the heat exchanger design and in the procedures of a heavy engineering works to maintain the tubing standards during subsequent manufacture are described. 5 references. (auth)

54072 (A/CONF.49/P-548) CONTRIBUTION TO THE QUESTION OF PRESSURE VESSEL SAFETY AGAINST BRITTLE FAILURE. **Kalna, K.; Brumovsky, M.** (Skoda Works, Pilsen (Czechoslovakia)); **Vacek, M.** (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Jun 1971. 18p. (CONF-710901-360). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Safety criteria and fracture analysis for reactor pressure vessels are discussed. Effects of specimen size and accumulated energy quantity on the fracture analysis diagram are studied. Neutron radiation effects on mechanical properties of pressure vessel steels are analyzed. 18 references. (D.C.C.)

54073 METHOD OF OPERATING A NUCLEAR REACTOR FACILITY WITH A STEAM COOLED FAST BREEDER REACTOR AS THE HEAT SOURCE. **(to Gesellschaft fuer Kernforschung mbH). British Patent 1,235,446. 16 Jun 1971. Priority date 16 Apr 1969, Germany.**

REACTORS, BREEDER—cooling system for heavy water steam cooled fast
REACTORS, FAST—cooling system for heavy water steam cooled breeder
REACTORS, SUPERHEATING—cooling system for heavy water steam cooled fast breeder (D.C.C.)

54074 IMPROVEMENTS IN OR RELATING TO GRAPHITE MODERATED NUCLEAR REACTORS. **Hutcheon, John Malcolm; Prince, Norman (to United Kingdom Atomic Energy Authority). British Patent 1,242,718. 11 Aug 1971. Filed 22 Jul 1968.**

Reference is made to means adopted to inhibit the radiolytic reaction between graphite and CO_2 by the use of CH_4, and to certain problems that arise, including radiolysis of the CH_4 and diffusion of coolant into the interior of the graphite blocks forming the moderator. Where access of coolant to the interior of the blocks is by diffusion, the CH_4 concentration will be less and the graphite reaction greater than at the exterior surfaces of the blocks; this problem increases with diffusion resistance. In the method described the composition of the coolant is such that it first encourages increase in porosity by radiolytic oxidation and is subsequently adjusted to inhibit such oxidation. The initial period during which CH_4 is omitted may be several years, and means are described for calculating this period. Hole drilling in the graphite blocks may with advantage be combined with the method described. (UK)

54075 THREE-DIMENSIONAL STRESS ANALYSIS OF A CONCRETE REACTOR VESSEL. **Tucakov, Joza. Nukl. Energ.: 5: No. 6, 30-7(1968-69). (In Serbo-Croatian).**

A review of a method called "dynamic relaxation" is presented which enables a numerical analysis of the stress in thick-walled vessels with no simplifications whatsoever. A description of the method for the analysis of the reactor vessel stress and strain distortion is also presented. The thermal stress in the concrete reactor vessel due to varying distribution and changes in the temperature over the vessel walls is analyzed. (auth)

54076 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. **Hooper, Alan Thomas (to United Kingdom Atomic Energy Authority). British Patent 1,241,441. 4 Aug 1971. Filed 7 Feb 1968.**

Reference is made to reactors employing porous fuel, the aim of which is to improve heat transfer between fuel and coolant. In the system described the coolant emerging from the fuel channels passes into a flow path extending radially to the core periphery. The coolant flow path in the core is axial into the open ends of tubular fuel elements and then radially with respect to the core axis, then through the tube walls and through the interconnecting interspaces between the fuel elements. A heat utilisation plant may be located at the core periphery, and the core periphery may comprise the shell side of a tube in a shell heat exchanger. Means may be provided for recirculating coolant leaving the heat exchanger shell to re-enter the core axially. (UK)

54077 FLUID COOLANT APPARATUS FOR A NUCLEAR REACTOR. **Strohmeyer, Charles Jr. (to Electrodyne Research Corp.).** U. S. Patent 3,578,563. 11 May 1971. Filed 22 Dec 1967.

The invention provides an apparatus for cooling a nuclear reactor wherein there are two systems for flowing a coolant fluid, one system having multiple conduits in parallel relationship with and individually encompassing a portion of the longitudinally disposed nuclear fuel elements, the other system cooling the exterior walls of the multiple conduits and wherein means are provided for controlling fluid flow selectively in each of the two systems. (auth)

54078 NEUTRONIC-ACOUSTIC DETECTION OF THE ONSET OF BULK BOILING IN LIQUID SODIUM. **Bonnet, J. A. Jr.; Osborn, R. K.** (Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng.: 45: No. 3, 314-20(Sep 1971).

A method is proposed to determine the initiation of bulk boiling in a sodium-cooled fast reactor. The technique could also be used to study two-phase single-component fluid behavior. The method consists of introducing a standing acoustic wave in a coolant channel of the core. This changes the coolant density, fission rate, and gamma-ray production by fission. The gamma rays leaking out of that region of the core are monitored with and without the acoustic waves. It is shown that this ratio is strongly coupled to the acoustic velocity, and this depends sensitively on the average void fraction in the channel. A drastic reduction in the acoustic velocity (by a factor of the order of one hundredth for sodium at 1830°F) with the formation of the first sodium voids makes this ratio very sensitive to the initiation of bulk boiling. (auth)

54079 IMPROVEMENTS IN OR RELATING TO EXPANSION JOINTS. **(to Gebr., Boehler and Co., Aktiengesellschaft). British Patent 1,242,986. 18 Aug 1971. Priority date 16 May 1969, Austria.**

JOINTS—design characteristics of telescoping tube bellows type expansion, for liquid metal cooled reactor piping system
REACTORS, LIQUID METAL-COOLED—piping system for, description of telescoping tube bellows type expansion joints for (D.C.C.)

54080 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. **Nichols, Ronald William (to Atomic Power Constructions Ltd.). British Patent 1,243,371. 18 Aug 1971. Filed 30 Nov 1967.**

Reference is made to integral reactors having auxiliary heat exchangers for removing substantially all the heat from the coolant during operating conditions that would otherwise give rise to excessive thermal transients in secondary systems associated with the main exchangers. A method of operation is described that is claimed to give improved reactor cooling, particularly during shutdown. This comprises shutting off the supply of secondary coolant to the main exchangers, shutting off the main turbine throttle valve, ensuring circulation of secondary coolant through the secondary exchangers, and adjusting the flow rate of coolant to a value such that the quantity of heat renewed by the secondary exchangers is such that steam is generated in the main exchangers at reducing temperature. (UK)

54081 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Shires, George Lister; Raven, Leonard Frederick Albert (to United Kingdom Atomic Energy Authority). British Patent 1,238,849. 14 Jul 1971. Filed 30 Oct 1967.

Reference is made to reactors employing cluster type fuel assemblies, cooled by fluid that is allowed to boil. The arrangement described seeks to avoid the condition known as "dryout." The fuel bodies are spaced apart in an annular cluster about an inner axial passage within which the coolant flows with a forced vortex motion, and imparts a free vortex motion to coolant passing through the cluster. A co-axial centrifugal separating device is preferably incorporated in the channel so as to effect the required forced vortex flow; this may take the form of a helical baffle, disposed to produce a swirl in the coolant flow, which in turn creates a radial pressure gradient providing a driving force for the inward migration of steam bubbles and a centrifugal action tending to throw water droplets radially outwards on to the fuel bodies. (UK)

Fuels

Refer also to abstracts 51561, 53889, and 54182.

54082 (A/CONF.49/P-158) IRRADIATION EXPERIENCE WITH FUEL FOR POWER REACTORS. MacEwan, J. R.; Bain, A. S.; Notley, M. J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.); Jones, R. W. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). May 1971. 17p. (CONF-710901-260). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

NPD and Douglas Point fuels have worked well to burnups of 12.5 MWd/kg U (natural U) and 18.5 MWd/kg U (enriched experimental fuel). By the end of 1970 more than 7200 bundles of Zircaloy-sheathed fuel had been installed: of these, <0.5% had defected and were discharged without difficulty. The features of these 80-mm-diameter 19-element bundles have been incorporated into the 100-mm-diameter 28-element bundles for Pickering reactors. In loop tests of Pickering bundles, elements operated at a peak power of 580 W/cm length have produced 8.2 MWd/kg U with a fission-gas release from the oxide of 15%. Instrumented fuel elements have shown how fission-gas release and sheath strain are related to power cycling and have enabled us to predict fuel behavior, even with power transients. Improved designs, including hollow pellets, may further reduce sheath strain. $(U,Pu)O_2$ and $(Th,U)O_2$ fuels have been studied for possible application to advanced fuel cycles. Uranium monocarbide is an acceptable fuel for organic-cooled power reactors. Clad in zirconium alloy or sintered aluminum powder, it has successfully achieved burnups of 11 and 14 MWd/kg U at ratings of 550 and 700 W/cm length respectively. Volumetric swelling averaged 2.0% per 10 MWd/kg U. Fission-gas release was <0.1%. Carbon-coated fully-enriched UO_2 microspheres, dispersed in a graphite matrix and sheathed in Zircaloy, are being developed for special applications in CANDU reactors. A burnup of 45% of the ^{235}U has been achieved at peak ratings of 720 W/cm length. Performance was excellent with negligible hydrogen pickup in the Zircaloy sheath. Extruded U_3Si fuel is potentially cheaper than UO_2 by several $/kg U, and ratings of 800 W/cm length have been achieved. Axial voids have accommodated the U_3Si swelling giving a diametral sheath strain <1% for exposures to 16 MWd/kg U at ratings of 500 W/cm length. 45 references. (auth)

54083 (A/CONF.49/P-275) PROGRESS IN BELGIUM IN NUCLEAR FUEL TECHNOLOGY. De Jonghe, P. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). May 1971. 22p. (CONF-710901-103). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Programs for the development of fuels and cladding materials for fast reactors are described. Fabrication and irradiation testing procedures and facilities for oxides and carbides are examined. 19 references. (H.D.R.)

54084 (A/CONF.49/P-288) CHOICE, DESIGN, AND DEVELOPMENT OF FUEL FOR A HTR. Aerts, L.; Storrer, J. (Societe Belge pour l'Industrie Nucleaire, Brussels); Gaube, M. (Nuclear Power Group, Knutsford (England)); Huet, J. J.; (and others) (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). May 1971. 18p. (CONF-710901-354). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Belgian program for development of fuel for high temperature gas cooled reactors is briefly reviewed. Primary emphasis has been placed on the design of low enriched and plutonium-bearing fuel. Fuel fabrication efforts and irradiation testing activities are described. 10 references. (H.D.R.)

54085 (A/CONF.49/P-312) TECHNIQUES FOR CORE DESIGN AND FUEL MANAGEMENT IN BOILING WATER REACTORS. Pershagen, B. (Aktiebolaget Atomenergi, Studsvik (Sweden)); Tenerz, E. (ASEA-ATOM, Vasteras (Sweden)). May 1971. 11p. (CONF-710901-202). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The optimization of core design and fuel management requires accurate calculational methods based on a detailed description of relevant neutronic and thermohydraulic processes. Since 1964 AB Atomenergi and AB ASEA-ATOM have carried out a joint research and development program for improving the understanding of the physics, heat transfer and fluid flow in boiling-water reactor cores. The program included a series of lattice experiments in a high temperature critical facility and full scale testing of fuel elements in a 9 MW heat transfer circuit. Experiments have also been performed in connection with the start-up of the 400 MWe Oskarshamn reactor. A summary of experimental results is given. Hand-in-hand with the experiments, a system of calculational methods were developed, including multigroup transport programs for the calculation of cell parameters, subchannel analysis of fuel element heat transfer and two-phase flow, and three-dimensional group diffusion programs for prediction of the overall static and dynamic core performance. The main characteristics of the methods are described, and some results of comparison with experiments are given. The accuracy of the calculational methods in relation to the requirements for core design and fuel cycle calculations is discussed. Possibilities of narrowing design margins by improving calculational methods are pointed out. 11 references. (auth)

54086 (A/CONF.49/P-392) IRRADIATION BEHAVIOR OF FAST REACTOR FUEL PINS AND THEIR COMPONENTS. Boehm, H.; Karsten, G.; Kummerer, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung. Allgemeine Elektricitaets-Gesellschaft, Grosswelzheim (West Germany)). Apr 1971. 16p. (CONF-710901-137). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The requirements of fuel pins for fast reactors with sodium, steam or helium cooling are discussed. Radiation effects on stresses shown to act upon fuel elements with respect to the fuel material, cladding, fuel pin, and bundle are studied. The results attained so far refer exclusively to oxide fuel. 41 references. (J.M.J.)

54087 (A/CONF.49/P-494) DEVELOPMENT OF A MANUFACTURING ROUTE FOR FUEL FOR THE MARK III GAS-COOLED REACTOR (HTR). D'Eye, R. W. M. (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group); Heal, T. J. (United Kingdom Atomic Energy Authority, Springfields (England). Production Group). May 1971. 8p. (CONF-710901-219). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The fuel element for the U.K. Mk III Gas Cooled Reactor (H.T.R.) comprises graphite blocks, pierced with holes which carry both the helium coolant and the fuel pin. The fuel pin contains annular fuel compacts of coated particles in a graphite matrix, clad in graphite sleeves. An initial fuel charge for a 600 MW(e) reactor contains typically 10^{10} coated particles and 10^6 compacts. With respect to fission product release, each coated particle is an individual fuel pin and ideally, at completion of manufacture, less than 2 in 10^4 should be defective. The implications of the combinations of large numbers, high standards and small size of the complex multi-coated particle are appraised and discussed from the product quality and hence process control aspect. Current development of the number of potentially relevant fabrication processes is outlined. A powder agglomeration and a wet method have been investigated for the fabrication of "green" UO_2 or UO_2/C kernels. These can be treated to form porous or dense oxide kernels or carbide kernels. The multiple coatings are deposited on the kernels in fluid beds and a range of coated particle specifications has been made in 5 in. diameter beds. Scale-up studies have been made with circular beds of larger diameter than this, as well as other designs such as a linear bed. In the final stage the coated particles are dispersed in a graphite matrix and the technology of forming such compacts in a variety of sizes has been established. A large scale irradiation program to support this reactor system and confirm the technology is well under way covering coated particles through to complete fuel pins. On a smaller scale the practicability of a coated particle fuel for a CO_2-cooled reactor system has been assessed. This led to the establishment of a production method for the manufacture of high quality SiC cans. An exploratory irradiation program has been completed. (auth)

54088 (A/CONF.49/P-495) DESIGN OF FUEL PINS FOR THE MARK III GAS COOLED REACTOR (HTR) SYSTEM. Cunningham, C. (British Nuclear Design and Construction Ltd., Whetstone (England)); Merrett, D. J. (Nuclear Power Group Ltd., Knutsford (England)); Prince, K. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Jun 1971. 12p. (CONF-710901-291). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The selection of a fuel pin design embraces not only the consideration of technical criteria but also economic constraints on fabrication costs in order to achieve an optimum balance of performance, capital and fuel costs for the reactor design as a whole. Demonstration that the design targets can be reached is achieved by an extensive supporting program of research and development. This includes both laboratory and irradiation experiments on component materials and complete fuel pins as well as preproduction manufacturing development. The selection of the Tubular Interacting fuel pin for the U.K. low enriched Mk III Gas Cooled Reactor (H.T.R.) is discussed. The results of parametric surveys leading to the choice of its leading parameters are analyzed. The evolution of the detail design is illustrated by considering in turn the principal technical constraints. These include the assessment of fuel and clad temperatures and temperature gradients, fast neutron effects and burnup and their influence on the mechanical and chemical behavior of the fuel pin. Particular attention is concentrated on the limitation of fission product release and on analyzing the stresses which can arise due to interaction between the graphite fuel tube and the fuel compacts it contains. The stability and vibration characteristics of the fuel pins during their residence in the core and during charge/discharge operations are also examined. (auth)

54089 (A/CONF.49/P-498) IRRADIATION TESTING OF FUEL FOR THE BRITISH PROTOTYPE FAST REACTOR. Lawton, H.; Parkinson, N. (Atomic Energy Establishment, Winfrith (England)); Bagley, K. Q. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group); Bellamy, R. G.; (and others) (Atomic Energy Research Establishment, Harwell (England)). Jun 1971. 12p. (CONF-710901-293). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Irradiation work in support of the development of a fuel design for the British Prototype Fast Reactor (P.F.R.) is described. Most of the experiments were performed in the Dounreay Fast Reactor (D.F.R.), with occasional supporting data supplied by irradiations in Material Testing Reactors. Main emphasis is placed on the results from D.F.R. subassembly experiments in which clusters of 77 pins of P.F.R. diameter fueled with mixed UO_2-PuO_2 have been irradiated to peak burnups in the range 5.4 to 7.3%. With certain reservations these demonstrate the soundness of the P.F.R. fuel element design and its ability to achieve reliably a peak burnup of 7.5%. Supporting single or 3-pin irradiations provide evidence of behavior up to 10% peak burnup, and include tests of different cladding, different fuel densities or maximum can temperature. Mixed carbide fuel has also been tested, both in individual pin tests and as a part-load for one subassembly. The data are discussed and correlated, general patterns of behavior demonstrated, failure mechanisms considered, and comparisons drawn between different fuel and clad types. Plans for the use of P.F.R. as an irradiation tool are described. These will enable the fuel element design to be optimized so that it can be used with confidence in the first British commercial fast reactor. (auth)

54090 (A/CONF.49/P-501) URANIUM DIOXIDE FUEL IN THE MK II GAS COOLED REACTOR (AGR). Greenough, G. B. (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group); Nairn, J. S. (United Kingdom Atomic Energy Authority, Sellafield (England). Reactor Group); Sayers, J. B. (Atomic Energy Research Establishment, Harwell (England)). May 1971. 12p. (CONF-710901-295). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

During its use as a nuclear fuel, UO_2 undergoes a complex series of changes resulting from a combination of the thermal and irradiation effects to which it is exposed. The various effects produced in this fuel under those operating conditions specific to the Mk II Gas Cooled Reactor (A.G.R.) program are described. 10 references. (auth)

54091 (A/CONF.49/P-608) IMPROVED FUEL ELEMENTS FOR GAS-COOLED, GRAPHITE-MODERATED, NATURAL URANIUM REACTORS: THE GRAPHITE-CORED ELEMENT. Faussat, A.; Millet, P.; Ollier, H.; Peray, R.; (and others) (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Jul 1971. 13p. (CONF-710901-405). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The fuel element of the N.U.G.G. reactor series at first contained a tube of uranium alloy U Mo 1.1% which was then changed to the alloy U Mo 1.1%-Al 0.05%-Sn 0.05%, of better mechanical properties and irradiation resistance. In order to increase the working temperatures, specific power and discharge burn-up a fuel element possessing a tube with a graphite core was designed, the other components of the cartridge remaining unchanged. The uranium alloy in this case is Sicral F.1, less absorbant neutronically than the alloys containing molybdenum. The irradiation results obtained on these fuel alloys in the range 300°C to 700°C and up to 8,000 MWd/t burn-up, using samples and actual fuel elements, together with the theoretical swelling processes are described. The performance obtained with the graphite-core element is discussed. Finally a new method of preparation of the graphite-core fuel tube by continuous casting is described: in a single operation it gives tubes with a very good metallurgical structure. 15 references. (auth)

54092 (A/CONF.49/P-609) FUEL ELEMENT OF THE REACTOR PHENIX. Dupouy, Jm.; Ginier, R.; Lallement, R.; Pajot, J.; (and others) (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Jul 1971. 24p. (CONF-710901-406). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Developmental research on the Phenix Reactor fuel elements is described. Included are studies on mixed UO_2-PuO_2, its physical and chemical properties, both in- and out-of-pile, and compatibility and structural properties of austenitic steel cladding. Thermal and hydrodynamic testing on the proposed fuel elements is discussed. Irradiation studies were carried out in the Rapsodie Reactor, approximating proposed Phenix conditions. Fabrication and testing equipment has been set up. 5 references. (J.M.J.)

54093 (A/CONF.49/P-610) NEUTRONIC STUDY ON FUEL BURN-UP IN THERMAL NEUTRON REACTORS. Laponche, B.; Brunet, M.; Chabrillac, M.; (and others) (Commissariat a l'Energie Atomique, Paris (France)). Apr 1971. 16p. (In French). (CONF-710901-252). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Since 1958, the Commissariat à l'Energie Atomique has made a large series of studies aiming to a better knowledge of the properties of plutonium bearing fuels, and particularly those of fuels irradiated in thermal power reactors. These studies dealt with integral measurements in heavy water graphite lattices on uranium-plutonium alloys, by progressive replacement and oscillations techniques, and with chemical and isotopic analyses as well as integral measurements (oscillations) on samples of irradiated fuels. Theoretical models have been developed in order to analyze the series of experiments, to take correctly into account spectrum effects, effective cross-section variations as a function of temperature (experiments up to 400°C) and changes in the isotopic composition of plutonium during burnup. A consistent set of cross sections has been defined. Compared to the values of the UKAEA 1967 library normalized to the last recommended values at 2,200 m/sec (WESTCOTT 1970), ^{240}Pu absorption and the ratio of η of plutonium-239 to η of uranium-235 have been decreased and the resonance amplitude of ^{239}Pu absorption and fission cross-sections is modified. The main parameters of the changes in the fuel during irradiation, such as the ^{238}U resonance integral and plutonium isotopes capture cross-sections, are adjusted on the results of analyses of irradiated fuels. Oscillations of irradiated fuels give the total absorption of fission products, from the knowledge of plutonium values. Methods and results thus obtained are applied to the study of the fuel burnup in French power reactors and to the estimation of plutonium production and of its isotopic composition. A direct application can also be made to plutonium recycle studies. 9 references. (auth)

54094 (A/CONF.49/P-821) PLUTONIUM FUEL DEVELOPMENT IN JAPAN FOR FAST AND THERMAL REACTORS. Nakamura, Y.; Suzuki, S.; Uematsu, K. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)); Shimokawa, J.; (and others) (Japan Atomic Energy Research Inst., Tokai). May 1971. 12p. (CONF-710901-343). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Studies on mixed Pu-U fuels of different enrichment are required in the Japanese nuclear power development programs. Mixed oxide fuel is designed as the initial core fuel of the experimental fast breeder "JOYO" now under construction and the prototype fast breeder "MONJYU." Studies are being carried out on fabrication techniques and physical properties that are necessary for fuel element design and for the estimation of irradiation behavior. Test samples are irradiated as capsules, fuel pins and small test assemblies in the fast test reactors. As for mixed carbide and nitride, the potential future fast reactor fuels, preliminary studies have begun. Recent activities concentrated on fundamental investigations on preparation, physical and chemical properties, compatibility and irradiation effects of these fuel materials. Mixed oxide fuel will be used as the recycling fuels in light water reactors. Together with fuel design studies and nuclear experiments, fabrication studies and their assessment irradiation on conventional pellet fuel and vibratorily compacted fuel have been performed. The Japanese experimental reactors, GETR, Halden HBWR and Saxton PWR, were used as the irradiation facilities. A partial Pu core experiment in the JPDR is being planned. Slightly Pu-enriched mixed oxide is to be used in the Japanese advanced thermal reactor with a heavy water moderated system. More than six hundred kilograms of mixed oxide have been fabricated and used for nuclear experiments. 49 references. (auth)

54095 (EURFNR-903) STUDY OF NATURAL FREQUENCIES, NORMAL AND EXPANSION MODES AS WELL AS DAMPING OF FUEL PINS OF INSTRUMENTED SUBASSEMBLY MOCK-UP OF FAST BREEDER REACTOR DESIGN Na-1/2. Krueger, W.; Schwemmle, R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK-1337. 55p. Dep. NTIS.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Investigations on free lateral vibration of fuel pins of the instrumented subassembly mock-up of the sodium-cooled fast breeder reactor design Na-1 are reported. The influence of the axial distribution of spacer grids on natural frequencies and the corresponding vibration modes was calculated and verified by experiments. The influence of the radial clearance in cells of spacer grids on the change of the normal modes was investigated experimentally. The frequency response functions were measured for the miniature pressure transducers which were mounted in one pin and in the subassembly sheath for the detection of the boundary layer pressure fluctuations in the subassembly. Experimental arrangements, results of investigations as well as instrumentation of the subassembly mock-up are described in detail. 8 references. (auth)

54096 (GEAP-10028-38) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Thirty-Eighth Quarterly Report, February 1971-April 1971. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Jun 1971. Contract AT(04-3)-189. 98p. Dep. NTIS.

FAST CERAMIC REACTOR — fuel elements for, development during February to May 1971

— core for, design and kinetics analyses of

— safety of, transient overpower and coolant loss effects on

INCOLOY 800 — radiation effects on swelling and mechanical properties of, fast neutron, (E)

LIQUID METAL FAST BREEDER REACTOR — fuel elements for, development of stainless steel clad plutonium oxide (PuO_2)-uranium oxide (UO_2)

NEUTRONS, FAST — effects on mechanical properties and swelling of Incoloy 800 and stainless steel, (E)

PLUTONIUM OXIDES PuO_2 — PuO_2-UO_2, radiation effects testing of fuels of

— PuO_2-UO_2, development of stainless steel clad fuel elements of

REACTOR FUEL ELEMENTS — performance of defected mixed oxide, in flowing sodium, (E)

— cladding for mixed oxide fast, development and testing of

— radiation effects testing of mixed oxide fast

STAINLESS STEEL — radiation effects on swelling and mechanical properties of Types 304, 316, and 347, fast neutron, (E)

— cladding for plutonium oxide (PuO_2)-uranium oxide (UO_2) fuel elements, development of

URANIUM OXIDES UO_2 — PuO_2-UO_2, properties of fuels of, mechanical, physical, and thermal, (E) (H.D.R.)

54097 (JAERI-Memo-4346) JPDR-II CORE DESIGN REPORT. (Japan Atomic Energy Research Inst., Tokyo). Jan 1971. 147p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The processes and result of the nuclear, thermal and hydraulic core performance calculations which have been done as core design studies of JPDR-II project (to double the JPDR thermal capacity) are outlined. Following parameter studies from 1964 to 1966, detailed core performance calculations were carried out. The desired thermal output will be obtained by changing the fuel numbers in an assembly from 6 × 6 to 7 × 7, and by setting the assembly coolant inlet velocity at about 1.8 m/sec. The overall core design calculations were done by using the parameters listed. It was concluded that with minor changes of a few design conditions obtained at the parameter study stage, the JPDR-II corecan, with integrity of the fuel, maintains satisfactory core thermal output through core life. (auth) (Japan)

54098 (NEDO-10017) FIELD TESTING REQUIREMENTS FOR FUEL, CURTAINS AND CONTROL RODS. Jones, D. R.; Hersum, T. G. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jun 1969. 9p.

Analyses and experimental data are presented to show that the testing of nuclear properties of core components in the field is not necessary. This conclusion is substantiated by analyses which show that the present pattern of quality control measures on fuel, curtains, and control rods provides sufficient assurance that the fuel and control-worth conform to design for both value and uniformity. (auth)

54099 (NP-18955) MOLTEN SALT BREEDER REACTOR CONCEPT. Quarterly Report for the Period Ending April 30, 1971. ([Bhabha Atomic Research Centre, Bombay (India)]). 8p. Dep. NTIS (U. S. Sales Only).

An experiment was carried out on the solubility of PuF_3 in $LiF-BeF_2-ThF_4$ (71.3, 15.5, 13.2 m/o) in the temperature range of 510° to 787°C. The solubility of PuF_3 in the salt mixture of the above composition was found to be between 0.7 m/o at the lowest temperature and around 4 m/o at the highest temperature. Analysis of the salt samples withdrawn from equilibrated melts using 10 micron and 15 micron porosity filter frits at the same temperature agreed within 5% thereby indicating that the measured solubility values are true within the limits of experimental errors. (auth)

54100 (NP-18956) MOLTEN SALT BREEDER REACTOR CONCEPT. Quarterly Report for the Period Ending January 31, 1971. ([Bhabha Atomic Research Centre, Bombay (India)]). 10p. Dep. NTIS (U. S. Sales Only).

The solubility of PuF_3 in $LiF-BeF_2-ThF_4$ mixtures of the composition of 68.2, 20.5, 11.3 m/o was determined in the temperature range of 550° to 775°C. The solubility was found to vary from about 0.8 m/o at 550°C to 5.6 m/o at 775°C. The preliminary values obtained on the solubility of PuF_3 are encouraging, as they are higher than the minimum solubility required to justify a detailed consideration of MSBR (Pu) concept. (auth)

54101 (WCAP-3385-28) SAXTON PLUTONIUM PROJECT. Quarterly Progress Report for the Period Ending June 30, 1971. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). Contract AT(30-1)-3385. 20p. Dep. NTIS.

PLUTONIUM — utilization in pressurized water reactor fuels, (E/T)

REACTOR FUEL ELEMENTS — performance of Zircaloy clad mixed oxide, in pressurized water reactors, (E)

REACTORS, PRESSURIZED WATER — fuel elements for, performance of Zircaloy clad mixed oxide, (E)

— fuels for, utilization of plutonium in, (E/T)

SAXTON POWER REACTOR — operation during April through June 1971

— fuel elements for, midlife handling and examination of core 3 (H.D.R.)

54102 (WCAP-4167-1) EEI-WESTINGHOUSE PLUTONIUM RECYCLE DEMONSTRATION PROGRAM. Progress Report for the Period Ending April 1970. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). May 1970. Contract AT(30-1)-4167. 158p. Dep. NTIS.

Progress on the EEI-Westinghouse Plutonium Recycle Demonstration Program for the period ending April, 1970 is reported in four sections. A separate abstract was prepared for each section. (G.M.C.)

For abstracts of individual sections see: 51675, 52429, 54103, and 54104.

54103 (WCAP-4167-1, pp 3.1-30) PRELIMINARY REGION DESIGN. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.).

In EEI-Westinghouse plutonium recycle demonstration program.

A preliminary region design study was conducted as part of the program to demonstrate plutonium recycle in pressurized water reactors. A 1000 MW(e) four-loop plant using a mixed-core of both plutonium and uranium fuels was selected as the basis for the preliminary design effort. The analysis consisted of calculations for a reference core fueled with both plutonium and uranium and for an identical core fueled with uranium. The results of the power distribution and depletion calculations are summarized. (H.D.R.)

54104 (WCAP–4167-1, pp 4.1-35) DEMONSTRATION ASSEMBLY DESIGN. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.).

In EEI–Westinghouse plutonium recycle demonstration program. The plutonium recycle demonstration fuel assemblies are composed of fuel rods containing PuO_2-UO_2 pellets clad with Zircaloy-4. Each assembly contains fuel rods with three different plutonium enrichments. The mechanical and nuclear design of the assemblies and the assembly thermal-hydraulic parameters is summarized. (H.D.R.)

54105 NUCLEAR REACTOR FUEL ELEMENT WITH NON-ALIGNED CHANNELING. Lofroth, Enar (to Aktiebolaget Atomenergi). U. S. Patent 3,580,808. 25 May 1971. Filed 26 Feb 1968.

A known type of a nuclear reactor contains vertical fuel elements in which a vertical channel is provided in the fissile fuel. It has been found that small particles or drops of fissile fuel collect on the bottom of the vertical channel. The inconvenience resulting from the collection of fissile fuel can be reduced if the vertical channel is divided into a plurality of shorter sections. (auth)

54106 PRESSURE TUBE TYPE FUEL ASSEMBLY FOR NUCLEAR REACTOR. (to Hitachi Ltd.). British Patent 1,236,331. 23 Jun 1971. Priority date 9 Feb 1968, Japan.

REACTOR FUEL ELEMENTS—design parameters of pressure tube assemblies, for heavy water moderated boiling water cooled reactors
REACTORS, HEAVY WATER-MODERATED—fuel element assemblies for boiling water cooled, description of pressure tube
REACTORS, WATER-COOLED—fuel element assemblies for heavy water moderated boiling, description of pressure tube (D.C.C.)

54107 IMPROVEMENTS IN OR RELATING TO PLUGS OR CLOSURES. West, Derek (to Flight Refuelling Ltd.). British Patent 1,241,802. 4 Aug 1971. Filed 28 Sep 1967.

Reference is made to plugs or closures for openings such as nuclear reactor fuel element stack pipes, and the object is to provide a plug having positive locking means for retaining it in position. A valve arrangement is provided for equalizing pressure on both sides of the plug before it is unlocked. (UK)

54108 REACTOR TECHNOLOGY. VOLUME 14, NUMBER 3. One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Washington, D. C.; Atomic Energy Commission (Fall 1971). 316p. GPO $0.75.

Operations and maintenance requirements for Dresden Power Reactor Unit 2, Fermi Fast Breeder Reactor, and SEFOR are reviewed. Radiation effects on swelling and creep in fast reactor fuels and fuel element cladding materials are studied. Separate abstracts are included for 6 of the articles presented. (D.C.C.)

For abstracts of individual papers see: 53970, 53971, 54109, 54110, 54218, and 54219.

54109 MINIMIZING SWELLING AND EMBRITTLEMENT OF FAST-REACTOR FUEL CLADDINGS. Kangilaski, Mihkel (Battelle Memorial Inst., Columbus). Reactor Technol.; 14: No. 3, 213-24(Fall 1971).

Liquid-metal-cooled fast breeder reactors (LMFBRs) are expected to produce most of the nuclear power in the near future. However, experimental results have indicated that stainless steel will undergo both swelling and embrittlement in the nuclear environment that is expected in LMFBRs. Implications of this swelling and embrittlement to the reactor design are discussed. Also, the numerous variables that affect the two phenomena are considered, along with approaches to alleviate or at least minimize them. 53 references. (auth)

54110 IN-REACTOR CREEP OF REACTOR MATERIALS. Gilbert, E. R. (Hanford Engineering Development Lab., Richland, Wash.). Reactor Technol.; 14: No. 3, 258-85(Fall 1971).

Irradiation creep is an important phenomenon in fast reactors. It affects the diameter changes and stress distributions in the cladding and in the nuclear fuel. It can also ameliorate distortions in structural components by allowing stress relaxation. Deformations that would lead to failure in postirradiation tests can be achieved by irradiation creep. Models are reviewed whereby irradiation either enhances creep or induces new mechanisms. The relative importance of these models is estimated. Data do not cover a sufficient range of temperature, flux, time, and stress to permit reliable prediction of materials behavior for the design goals of future liquid-metal-cooled fast breeder reactors (LMFBRs). 105 references. (auth)

54111 STRESS ANALYSIS OF COATED FUEL PARTICLES FOR DETERMINATION OF THEIR BURNUP BEHAVIOR IN HIGH TEMPERATURE REACTORS. Bongartz, K. (Kernforschungsanlage, Juelich, Ger.). pp C1/2.1-8 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971). (In German).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Stresses are induced into the coatings of a spherical coated fuel particle in a HTR mainly by dimensional changes of the material cuased by the fast neutron flux and by fission gas pressure and swelling of the fuel material caused by burnup. By these stresses the lifetime of the fuel in the reactor is limited. Using a model established by H. Walther (SORIN) the lifetime of a multilayer particle for a power reactor was calculated. The calculation results indicate how the lifetime depends on the geometry of such a particle. Furthermore the results of an irradiation test with practically no burnup were compared with the calculation result. This led to an understanding of the mechanisms induced by the fast dose which most probably should have caused the disintegration of the particle in the test. 3 references. (auth)

54112 THEORETICAL STUDIES ABOUT SPECIAL COMPACT MODELS WITH RESPECT TO THE IRRADIATION BEHAVIOR OF BONDINGS AND COMPACTS OF COATED REACTOR FUEL PARTICLES. Drittler, K. (Institut fuer Reaktorsicherheit, Cologne). pp C1/3.1-18 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971). (In German).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

In all high temperature reactors planned, built or under operation, fuel particles are used. In order to prevent the escape of fission products these particles are coated with different layers of pyrolitic carbon or silicon carbide. Due to various reasons, mainly due to safety aspects, these coated particles (having a diameter in the range of 0.4 to 1 millimeter) are compacted. Under irradiation the particles and the matrix material generally have different length changes which cause internal stresses. During normal operation time of power reactors these stresses can rise to an extent that the compact is destroyed. In order to determine what properties of coated particles and matrix material have to be changed so that these internal stresses are reduced to the lowest possible value, the internal stresses of compact models with spherical particles were calculated by analytical methods. It was assumed that the absolute value of the differences of the elastic properties of particles and matrix is not too large compared to that of the absolute values of the properties themselves. The evaluation of the derived formulae was done numerically. The results show that regarding the stresses there is only a weak influence of the geometrical dimensions and parameters. 11 references. (auth)

54113 STRESS AND STRAIN CALCULATIONS ON COATED PARTICLE FUEL AND COMPARISON WITH IRRADIATION RESULTS. Thomson, J. M. (Belgonucleaire, Brussels). pp C1/4.1-14 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

The use of a computer code, written for a spherical geometry and based on the mechanical and physical properties of the materials used for the coated particle fuel, allows the prediction of the mechanical behavior of the HTR fuel concept. 9 references. (auth)

54114 CLADDING STRENGTH ANALYSIS UNDER COMBINED CREEP AND PLASTICITY EFFECTS IN FAST REACTOR ENVIRONMENT. Guyette, M. (Belgonucleaire, Brussels). pp C2/1.1 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

An analysis of the clad behavior of oxide fuel elements is performed by means of the CRASH III computer program, which constitutes an improved version of the early CRASH II B program. The CRASH III program, allowing the calculation of tri-axial stress and strain in an axisymmetrical sheath, takes into account the combined effects of the creep and the plasticity of the material. The creep and plastic strains can be any functions of the temperature, the generalized stress and the time. (auth)

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54115 MECHANICAL STRESS OF FUEL ROD BUNDLES THROUGH AZIMUTHAL TEMPERATURE GRADIENTS IN FUEL ELEMENTS WITH ECCENTRIC GEOMETRY. Fischer, M.; Hofmann, F.; Kreig, R. (Kernforschungszentrum, Karlsruhe, Ger.). pp C2/2.1-15 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

A theoretical analysis of the temperature and elastic stress distribution in symmetrical and asymmetrical triangular rod clusters is presented. The analysis is applied to sodium as a coolant with fully developed turbulent flow. The temperature and stress analysis was carried out at axial sections where both the volume increase by swelling as function of temperature and temperature gradients in radial and peripheral direction lead to the critical conditions. Numerical results are presented for some specific cases (i.e. for a rod bundle with pitch to diameter ratio 1.21 and displacements $\xi = 0$; 0.1; 0.2 mm). The results show that already small displacements of the fuel rod in tightly packed rod bundles cause considerable temperature and axial stress variations in the cladding in circumferential direction. 9 references. (auth)

54116 FAILURE CHARACTERISTICS OF ZIRCALOY CLAD UO_2 FUEL RODS UNDER LOSS-OF-COOLANT CONDITIONS. Lorenz, R. A.; Osborne, M. F.; Parker, G. W. (Oak Ridge National Lab., Tenn.). pp C3/5.1-14 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Studies of the effects of a loss-of-coolant accident on the fuel rods are of primary importance in assessing the safety of water-cooled power reactors. A program to investigate the behavior of Zircaloy cladding in rapid thermal transients is described. The results of fuel rod failure experiments performed in steam on both irradiated and unirradiated fuel rods are presented. These results are compared with the mechanical properties of Zircaloy and a failure model. Fuel rod cladding expansions of 15 to 75% were observed with rods that ruptured in the temperature range 800 to 1400°C with internal pressures varying from 3.5 to 70 atmospheres. At fast neutron exposures of $\sim 1 \times 10^{21}$ nvt (>1.0 MeV) the average expansion of irradiated rods was about 70% that of unirradiated rods. Steam oxidation limited expansion at the higher temperatures (>1100°C), and the cladding exposed to steam at >1200°C was severely embrittled. The data correlated reasonably well with a failure model based on secondary creep which permits reliable predictions of failure temperature. The results of these tests indicate that fuel rod expansion may seriously impair the efficiency of emergency cooling in a reactor accident. 21 references. (auth)

54117 IMPORTANCE OF DESIGN: SAFETY INTERACTIONS ON RATE OF FUEL FAILURE PROPAGATION. Khan, E. U. (Babcock and Wilcox Co., Lynchburg, Va.). pp C4/6.1-20 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Under normal or near normal operating conditions there are potentially four causes of fuel failure propagation in LMFBR's. These are briefly described. Models have been developed to predict the possibility of fuel failure propagation within the core. These have shown that fission gas-blanketing should not lead to failure propagation beyond one assembly. It appears that the detrimental affect of nuclear transients occurring during normal operation on fuel failure propagation can be designed out. Thus, small scale flow blockage caused by pin motion, cladding deformation of an initially defective pin, fuel swelling and fuel debris is the most serious mechanism which could lead to fuel failure and to fuel failure propagation. A reactor core with good coolant mixing and strong, well designed assembly cans may delay propagation of failure to other assemblies. Any delay in failure propagation may be as good as preventing it if there are adequate detection devices with timely operation of counteraction systems. 18 references. (auth)

Auxiliary and Emergency Systems

54118 (NEDO-10320) THE GENERAL ELECTRIC PRESSURE SUPPRESSION CONTAINMENT ANALYTICAL MODEL. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr 1971. 47p.

The analytical model used to evaluate the short term response of pressure suppression containments to loss-of-coolant accidents is presented. Comparisons are made between model predictions and available experimental data. The various assumptions involved are listed. The conservatisms of the model presented are discussed. It is demonstrated that the model over predicts available test data by a considerable margin. Since all the conservatisms will be present when full scale containments are being evaluated, it can be concluded that the resultant peak calculated pressures will be considerably greater than those which would actually occur. This over-prediction must be kept in mind when design margins are being selected. The overall analytical modeling of the pressure containment design can conveniently be considered in terms of the various components of the model. These components are: the vessel blowdown model; the drywell pressure model; the vent clearing model; the vent flow model; and the suppression chamber model. Each of these is described in detail. 8 references. (auth)

54119 (RT/ING-(71)2) METHOD OF LIMITING THE DEGREE OF CONTAMINATION OF THE PRIMARY CIRCUIT PROCEEDING FROM THE OPEN FUEL IN SODIUM FAST POWER REACTOR. Barilli, L.; Bruzzi, L.; Cicognani, G.; Gondoni, G. R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). [1970]. 42p. (In Italian). (CONF-700970-1). Dep. NTIS (U. S. Sales Only).

From Symposium on the applications of transport theory; Oxford, England (1 Sep 1970).

The operating conditions of the fission gas discharge device for the PCC sodium cooled fast power reactor fuel element are analyzed. The conditions of sodium non-reentry in a typical operating sequence are particularly examined. On the basis of the radioactivity production rate released to the primary circuit as fission gas, a preliminary design of a clean-up system capable of reducing considerably the cover gas specific activity is also carried out. 7 references. (auth)

54120 CRITERIA FOR EMERGENCY CORE COOLING SYSTEMS FOR LIGHT-WATER POWER REACTORS. New York; American National Standards Institute (1971). 3p. Available from American National Standards Institute, New York.

Reevaluation of performance requirements for water cooled power reactor emergency core cooling system is presented. (D.C.C.)

54121 NUCLEAR CONTAINMENT SYSTEM. (to Westinghouse Electric Corp.). British Patent 1,235,648. 16 Jun 1971. Priority date 3 Apr 1969, United States.

REACTOR CONTAINMENT SYSTEMS—design characteristics of ice condenser, for pressurized water reactor
REACTORS, PRESSURIZED-WATER—containment system for, description of ice condenser (D.C.C.)

54122 INSPECTION OF THE JPDR PRESSURE VESSEL WITH A BORESCOPE. Okuma, Akira; Hashimoto, Takashi (Japan Atomic Energy Research Inst., Tokai). Hihakai Kensa; 18: 517-22(Nov 1969). (In Japanese).

Cracks had occurred in the clad inside the top of JPDR pressure vessel. In this connection, the bottom and nozzle parts near the pressure vessel were observed with a borescope. Because of the peculiar location etc., the observation encountered considerable difficulties. The borescope and polishing techniques employed, the procedure, and the results are described. Polishing devices were specifically designed for the nozzle parts and the vessel bottom; nylon brushes with alumina were employed to minimize the closure of cracks. The borescope technique consisted of iodine-lamp illumination, objective, relay lenses, eyepiece and photography. The results of observation (direct, photographic, etc.) were analyzed. Cracks were detected in one nozzle part; but, overall, abnormal cracks were observed. Problems in the observation, such as the coloring of lenses due to radiation, etc., are also described. (Japan)

54123 INSPECTION OF THE JPDR PRESSURE VESSEL BY THE ULTRASONIC FLAW DETECTION METHOD. Takada, Minoru; Futamura, Yoshiaki (Japan Atomic Energy Research Inst., Tokai). Hihakai Kensa; 18: 523-8(Nov 1969). (In Japanese).

Prior to the actual inspection of the JPDR pressure vessel, preliminary experiments were made: calibration-use test specimens with artificial flaws, and nozzle-part mockups also with similar flaws. The supersonic device employed was BRANSON SONORAY 301. Flaw detection was made for those on the inside surface of the pressure vessel from the outside. The contact of probes, their movement, etc. were all made manually. The beam scanning was for the shell, nozzle part, corner at the nozzle inside, and its vicinity. A beam was incident on a point of observation from four directions. The results by the supersonic technique were compared with those by a borescope and a smeck gauge. The cracks determined by the three techniques were those on the inside surface of the vessel body, close to a nozzle; these did not reach the base metal. One feature of the supersonic technique is the detection of internal flaws; it is its shape for a borescope; and its depth for a smeck gage. (Japan)

Operation and Economics

Refer also to abstracts 54231 and 54234.

54124 (A/CONF.49/P–151) CANDU NUCLEAR POWER SYSTEM: COMPETITIVE FOR THE FORESEEABLE FUTURE. Hart, R. G. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment); Haywood, L. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.); Pon, G. A. (Atomic Energy of Canada Ltd., Sheridan Park (Ontario)). May 1971. 15p. (CONF-710901–170). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The CANDU system is based on heavy-water-moderated pressure-tube reactors noted for their good neutron economy. A major attribute of the system that has not been internationally recognized is its ability to become even more economically attractive with more advanced coolants or fuel cycles. The technologies of three coolant options, pressurized heavy water, boiling light water and organic liquid, are now developed, and preliminary work on a fourth option, liquid metal, has commenced. The natural-uranium fuel cycle has reached the commercial stage and work has started on plutonium recycle and thorium options. Operation of NPD and Douglas Point and construction of Pickering have shown that the pressurized-heavy-water natural-uranium option is competitive with other power sources. Low fuelling costs, on-power fuelling, easy control and acceptable capital costs have been demonstrated; methods of handling heavy-water leakage have been learned. The boiling-light-water natural-uranium option, now being demonstrated at Gentilly, provides reduced capital and operating costs by reducing heavy-water inventory, eliminating steam boilers and eliminating heavy-water upkeep costs. These savings are partially offset by higher fuelling costs, but there is a net energy cost gain and the system is less sensitive to increased interest rates. The organic-cooled natural-uranium option, now being demonstrated in WR-1, also provides lower capital and operating costs by reducing heavy-water inventory, increasing efficiency, eliminating heavy-water upkeep costs and providing an inactive heat-transport circuit. With uranium monocarbide fuel these savings are partially offset by higher fuelling costs, but if uranium metal can be developed as fuel, lower fuelling costs will also be obtained. In all options, capital costs can be further reduced by more fuel sub-division thus achieving increased channel power. In all but the uranium-metal option, the fuelling cost rise resulting from increased sub-division can be minimized by recycling plutonium or using thorium. 13 references. (auth)

54125 (A/CONF.49/P–157) LARGE-SCALE NUCLEAR ENERGY FROM THE THORIUM CYCLE. Lewis, W. Bennett; Duret, M. F.; Craig, D. S.; Veeder, J. I.; (and others) (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1971. 15p. (CONF-710901–175). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Nuclear reactors with capacities of several thousand megawatts offer great promise for water desalination, for agro-industrial complexes and for very large electrical power networks, but various delays have so far prevented the vision from becoming a practical reality. The attraction of large capacity is the prospect of very low fuelling, operating and maintenance costs — less than 1 m$/kWh (electric). An essential requirement is high availability; this demands simplicity of the plant and all auxiliaries, easy access to keep maintenance time short, and a long unattended life for all components. Energy from thorium is very promising, especially in conjunction with organic-cooled heavy-water-moderated reactors. A new design of thorium-oxide fuel promises ratings as high as 50 to 80 kW(+)/kg Th, yielding 35 MWd/kg Th over irradiations of two to four years with high neutron economy. Such a near-breeder fuel cycle requires a small ancillary supply of neutrons. Several cycles are discussed. A major advance in plant availability can be achieved by using organic-liquid coolant. Good neutron economy is preserved with cool heavy-water moderator. It is envisaged that large reactors with these features could be completed by about 1985. The capital cost would depend on the state of technology in the industry undertaking the work, but analysis of the component specifications indicates a substantially lower cost per kilowatt than for the CANDU reactors of today. When the initial provision of the reactor, fuel reprocessing plant and generating equipment is clearly separated from the subsequent low-cost operating and maintenance, such reactors are seen to be well suited to programs of capital aid. 28 references. (auth)

54126 (A/CONF.49/P–185) PLUTONIUM UTILIZATION IN THERMAL AND FAST REACTORS. Sani, L. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)); Schileo, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1971. 16p. (CONF-710901–88). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In 1966, ENEL, in cooperation with EURATOM, launched an extensive research program to establish the feasibility of recycling plutonium in thermal reactors by means of UO_2-PuO_2 fuel assemblies. These assemblies were manufactured to standard fabrication techniques and were loaded in one of the ENEL reactors to verify their performance in actual operating conditions. The behavior of these assemblies in normal operation combined with the results of criticality experiments and gamma scanning confirmed the validity of this approach. In that same year, CNEN launched the Plutonium Program and the Fast Reactor Program. The former aimed at acquiring know-how in the manufacture of ceramic-grade plutonium fuel in a purposely built laboratory. As part of the development work, an extensive series of irradiation experiments on plutonium fuel was performed in prototype reactors. The Fast Reactor Program included research and development activities concerning fuel for fast reactors with a view to obtain the necessary know-how to fabricate fuel elements capable of operating reliably at high specific power and high burnups. (auth)

54127 (A/CONF.49/P–186) CNEN ACTIVITIES ON THE URANIUM–THORIUM CYCLE APPLIED TO WATER REACTORS. Baldetti, S.; Doria, F.; Gabaglio, M.; Grifoni, S. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1971. 17p. (CONF-710901–189). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A program aimed at assessing the economics of the thorium–^{233}U cycle in water reactors is described. The program includes: (1) economic evaluation; (2) neutron physics experiments; (3) fuel fabrication and irradiation experiments; and (4) reprocessing and remote refabrication. 15 references. (H.D.R.)

54128 (A/CONF.49/P–277) PLUTONIUM RECYCLE IN LIGHT WATER REACTORS. Bairiot, H. (Societe Belge pour l'Industrie Nucleaire, Brussels); Van Den Broeck, H. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). May 1971. 19p. (CONF-710901–195). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Belgian plutonium recycle program, started in 1958, was gradually increased to cover most aspects of plutonium utilization in LWR's. Prospective studies dealt with plutonium availability, manufacturing costs and cost of interim storage to benefit by large scale facilities. The incentives to use plutonium in first generation PWR's (stainless steel cladding, cruciform rods, flexibility for progressive conversion to plutonium fuelling) and in BWR's (separate fuel element channels, multiple enrichment elements), and the simultaneous recycling in both reactor types of the enriched uranium recovered from reprocessed fuel were examined in detail. The nuclear PANTHER code chain was tested on results of about 130 critical experiments in the VENUS facility, from simple lattices to mock-ups of recycle configurations, using almost 3000 pelleted or vibrated oxide fuel rods. The thermohydraulic codes were calibrated for special situations encountered in plutonium fuel environments. COMETHE and CRASH, fuel rod design codes, were checked against many irradiation experiments. The fuel development was backed by the irradiation of over 80 specimens in BR2 and DIORIT, covering heat ratings up to 1300 W/cm, cladding temperatures up to 600°C and burnups up to 50.000 MWd/t. Both pelletizing and vibrocompaction manufacturing techniques were developed, from laboratory to pilot stage; a large plant is now under construction. These activities were backed by a diversified assessment and demonstration program. BWR plutonium recycle assemblies were designed for KAHL and DODEWAARD, fuel was fabricated for GARIGLIANO and DODEWAARD and there was a close collaboration with ENEL's experimental program in GARIGLIANO. As for PWR's, various recycle schemes, covering four reactor cycles, were studied for SENA and TRINO type plants; shut-down margins and control rod worths were investigated. Plutonium fuel was gradually introduced in the BR3 from 1963 on; at the end of 1970, a peak burnup of 40.000 MWd/t was reached in a UO_2-PuO_2 assembly. 18 references. (auth)

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54129 (A/CONF.49/P-293) MULTILEVEL DATA-BASED COMPUTER CODE SYSTEM FOR IN-CORE FUEL MANAGEMENT IN LIGHT WATER REACTORS. Sauar, T. O.; Boerresen, S.; Haugen, J.; Nitteberg, E.; (and others) (Institutt for Atomenergi, Kjeller (Norway)). May 1971. 18p. (CONF-710901-197). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Utility requirements for in-house fuel management capabilities are met by providing an automated multilevel computational system which is tailored to the characteristics of LWR cores and their fuel cycles. Adequate treatment of important nuclear and thermodynamic effects is ensured in integrated computer codes at various levels of calculational sophistication. Emphasis has been placed on automation by the use of a common data-base for transfer of data between codes and easy access to previous data. 16 references. (auth)

54130 (A/CONF.49/P-346) FUEL MANAGEMENT STUDIES FOR PRISMATIC TYPE HIGH TEMPERATURE REACTORS. Gutmann, H.; Daub, J.; Hansen, U.; Mandl, F.; (and others) (Atomic Energy Establishment, Winfrith (England)). Jun 1971. 18p. (CONF-710901-278). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The basis of these studies is a realistic prismatic core design proposed by the OECD High Temperature Reactor DRAGON Project for a station of 640 MW(e) with helium cooling and a secondary steam cycle. The core is made up of 264 fuel element columns each consisting of 5 hexagonal fuel blocks. Each block contains compacted coated particle fuel in inside and outside cooled fuel pins. The fuel columns are replaced on-load. The fuel management for the approach to equilibrium and for the equilibrium itself is investigated. The use of zero-, one- and two-dimensional studies is discussed and the conclusion drawn to which degree of costly core representation one has to go to achieve satisfactory predictions. Typical utility requirements, e.g., electricity demand curves, were the basis of the xenon override capacities and safe shut down margins incorporated in these studies. The investigations concentrate on low enriched fuel cycles because these are the ones which are considered for the first prismatic HTR power station in Europe. They include fuel cycle cost estimates which assist in deciding which of the investigated running-in approaches should be chosen for real operation. The particular points and restrictions which have to be heeded in working out fuel management schemes for HTR's are described. These include limiting features like fast neutron dose for structural graphite and graphite consolidated fuel compacts, burnup of coated particle fuel and local power peaks. (auth)

54131 (A/CONF.49/P-389) COMPARISON OF HIGHLY ENRICHED AND LOW-ENRICHED URANIUM FUEL CYCLES IN HIGH TEMPERATURE REACTORS. Ehlers, K.; Schloesser, J. (Brown Boveri/Krupp, Cologne, Ger.); Hackstein, K. G. (Nuklear-Chemie und-Metallurgie G.m.b.H., Wolfgang bei Hanau (West Germany)); Merz, E. (Kernforschungsanlage, Juelich (West Germany)). Apr 1971. 20p. (CONF-710901-135). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

For a 600 MW(e) high temperature reactor the thorium fuel cycle with reprocessing of the breed elements and recycling of the bred fissile material, as well as the uranium cycle with reprocessing of the fuel and sale of the spent uranium and the bred plutonium were optimized with regard to fuel cycle cost. In selecting the reference cycles, special emphasis was placed on a comparable status of the fuel element development. Hence the design data were chosen so that the constraints regarding fast dose, burn-up, heavy metal density of the fuel matrix, maximum fuel and wall temperatures, and maximum power output per fuel element are not exceeded. For both reference designs, the costs of the outer fuel cycle for fabrication and reprocessing at an installed capacity of 5000 MW(e) were determined. Due to the influence of the specific costs on the fuel cycle parameters, a reoptimisation proved to be necessary. It is shown that the thorium cycle leads ultimately to lower fuel cycle costs whereas the uranium cycle could be introduced with less development effort. (auth)

54132 (A/CONF.49/P-471) OPERATIONAL CHARACTERISTICS OF THE STEAM GENERATING HEAVY WATER REACTOR. Smith, D. (Atomic Energy Establishment, Winfrith (England)); Dickson, G. K. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group); Pickman, D. O. (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group). Jun 1971. 12p. (CONF-710901-284). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Steam Generating Heavy Water Reactor (S.G.H.W.R.) is a direct cycle, light water boiling reactor using pressure tube construction. Ready access is therefore possible to the fuel with consequent flexibility in fuel management. Additional moderation is provided by heavy water which operates at atmospheric pressure so that leakage problems are negligible. A 100 MW(e) reactor designed to prove full size fuel and pressure tube units appropriate to larger sized reactors of 600 MW(e) and above has successfully operated at Atomic Energy Establishment Winfrith since January 1968. The operating and maintenance experience is described, together with an analysis of component performance and a summary of the materials monitoring program. Examples are presented to show how the operational experience has led to modifications of the Winfrith reactor which will be relevant to the design of the later larger plants. Particular reference is made to maintenance work on active components. A brief description is given of the removal of six experimental pressure tubes and their replacement by units of standard material. (auth)

54133 (A/CONF.49/P-472) REVIEW OF EXPERIENCE RELEVANT TO THE OPERATION OF COMMERCIAL FAST REACTORS. Mummery, P. W.; Barclay, F. J.; Evans, A. D. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). Jun 1971. 12p. (CONF-710901-211). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Reliability, availability, maintainability and ease of control are the most important aspects to be considered in any assessment of the operational viability of commercial fast reactor (C.F.R.) power stations. From studies of operating experience on nuclear and conventional power stations within the U.K. and the rest of the world it is possible to establish the factors which have most relevance to performance under these general headings and the more important factors are identified. These include the periodic and relatively prolonged outages for plant overhaul and inspections; the significance of off-load charge/discharge arrangements on nuclear stations; the ability to remove and replace plant items and the reliability of key items; and the likely level of spurious trips. Experience from operation of the Dounreay Fast Reactor and from extensive component development rigs has been used to make detailed assessments of the likely operational performance of the 250 MW(e) Prototype Fast Reactor (P.F.R.). This has established the influence of the performance of such key features as the primary and secondary liquid metal pumps and the steam generators and the advantages of the ability to continue operation with some of these units isolated. The reliability and speed of operation of the off-load fuel handling equipment has been assessed including the influence of fuel performance particularly in the context of continued operation following fuel failures. From these assessments for P.F.R. some general conclusions on the operational performance of C.F.R. stations will be drawn. The maintenance implications arising from the use of liquid metal coolant are considered against the background of the very considerable experience available in the U.K. For removable plant items it has shown that no major problems should arise and for fixed components, particularly within the primary circuit, the view is put forward that fast reactor power station designs should permit good access for repair of major faults. 8 references. (auth)

54134 (A/CONF.49/P-497) OPTIMISATION OF FUEL CYCLES AND THE INFLUENCE OF ECONOMIC GROUND RULES. Dickinson, N.; Rutherford, R.; Scott, J. (Nuclear Power Group Ltd., Knutsford (England)). May 1971. 11p. (CONF-710901-292). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The ground rules which affect the choice of uranium fuel cycles are discussed under three headings: financial, fissile material costs, and system conditions. Typical examples are given. Detailed descriptions of fuel cycles for the Steam Generating Heavy Water Reactor (S.G.H.W.R.), the Mk II Gas Cooled Reactor (A.G.R.) and the Mk III Gas Cooled Reactor (H.T.R.) are given and attention is drawn to the way in which both reactor features and economic rules introduce differences in fuel cycles. Examples, for on-load refuelling, are the just-critical cycle for the Mk II G.C.R. which is not economic for Mk III G.C.R.; for off-load refuelling, the S.G.H.W.R. has channel access suited to frequent refuelling and has a liquid moderator, permitting the use of soluble poisons for the control of reactivity variations during burnup. The reasons for the choice of on-load cycles and the features of off-load cycles are discussed. A simplified model of the fuel cycle is used to show the effect of variations in economic ground rules on fuel cycle costs. Important examples are in the increased importance of the early phases of the fuel cycle if the amortization period is short; the effect of load factor, uranium and fabrication costs on the incentive to delay the onset of refuelling and the influence of the credit given for plutonium. A breakdown of the costs is used to explain how, using the combination of ground rules appropriate to a particular environment, the optimum cycle can be selected for each system. The adjustments to the fuel cycle, which are necessary as a result of uncertainties in nuclear calculations, are discussed in the light of the fuel and reactor performance guarantees required by a utility. (auth)

54135 (A/CONF.49/P–709) EFFICIENT UTILIZATION OF FUEL IN NUCLEAR FAST POWER REACTORS. Leipunskii, A. I.; Orlov, V. V.; Lytkin, V. B.; Troyanov, M. F.; (and others) (State Atomic Energy Committee, USSR). Aug 1971. 34p. (CONF-710901–460). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Fast sodium cooled power reactors play an important role almost in all long-range nuclear power development programs. Recent accurate data show, that in spite of the fact that some reactor performances have become worse, in general, fast reactors preserved their advantages over thermal reactors. Several aspects of atomic power development with fast reactors are considered. The effect of data on reactor performance and fuel cycle parameters on power plant development is discussed. 16 references. (auth)

54136 (A/CONF.49/P–750) EXPERIENCE IN FAST REACTOR OPERATION AND DESIGN IN THE USSR. Leipunskii, A. I.; Kazachkovskii, O. D.; Mitenkov, F. M.; Orlov, V. V.; (and others) (State Atomic Energy Committee, USSR). Aug 1971. 29p. (CONF-710901–462). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In the USSR, sodium-cooled fast breeder-reactors are considered as the basis of future development of the national atomic power. The BR-1, BR-2, BR-3, BR-5 and BFS experimental reactors were built for development of scientific and technical foundations and accumulation of required experience, the results thus obtained are well known. The construction of the first large 150 MW(e) nuclear power station with the BN-350 fast reactor, designed for both production of electric power and sea water desalination (120 10^3 m^3/d), is being completed now in Shevchenko. The second 600 MW(e) BN-600 reactor is under construction now as the Beloyarsk nuclear power station sixth unit. The state of construction, equipment, fabrication, tests and mounting for these nuclear power stations and BD-350 commissioning program is described. Experience of 60 MW(th) BOR-60 reactor construction and commissioning at Melekess is summarized. Characteristics and research results, attained at BFS-P critical assembly, constructed in 1969 at Obninsk for physical modeling of large fast reactors, are reported. (auth)

54137 (A/CONF.49/P–761) NUCLEAR ENERGY AND ELECTRIC POWER PROGRAMS IN THE DEVELOPING COUNTRIES. Jul 1971. 8p. (CONF-710901–447). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

54138 (A/CONF.49/P–822) STUDIES ON PLUTONIUM UTILIZATION IN POWER REACTORS AND SYSTEM ANALYSIS OF LONG-TERM FUEL CYCLE. Nozawa, S.; Yasukawa; S. (Japan Atomic Energy Research Inst., Tokyo); Furuhashi, A. (Tokyo Univ. (Japan)). May 1971. 12p. (CONF-710901–344). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Studies on Pu utilization in power reactors and system analysis of long-term fuel cycle are reviewed. The evaluation of nuclear data and their conversions to group constants were processed on the basis of ENDF-A and B data. Design assessments of plutonium recycling in LWRs are studied on the basis of direct substitution both in full core and in partial core. For HWR design, a computer code system ATRASS is developed and the accuracy of the system is checked against experimental data. Through the assessment works on HWR, Pu self-sustaining cycle has a merit of reducing positive void reactivity, and may attain about 15000 MWD/T fuel burnup with natural U feeding. As for HTGR, its fuel cycle cost based on low enriched U or on Th mixed with highly enriched U becomes comparable to each other, when the price of natural U and the cost of separative work rise. When LWR and FBR are installed, about 6×10^5 metric tons of natural U will be consumed before 2030 when the nuclear power generating system will become self-standing. To reduce the demand for natural U, it is effective to improve the characteristics of FBR and to introduce HWR as well as to reduce the fuel burnup of LWR after the introduction of FBR. Time delay in the re-use of fissile material has a very large effect on natural U demand, so that the suppression of it becomes very important in the expanding power generating program. The role of Pu-recycled thermal reactors is discussed with strategic evaluation of ATR and FBR in reducing U demand. Introductions of Pu-recycled thermal reactors have the effect of reducing Pu-pile-up, however these result in much more consumption of natural U. Also the effects of introducing Th loaded HWR (or HTGR) and MSBR, into the LWR-FBR system are presented. 30 references. (auth)

54139 (JUL–759–RG) STROKOOP: A PROGRAM ON LONG-TERM INVESTIGATION OF COST-OPTIMUM NUCLEAR POWER SYSTEMS. INPUT DESCRIPTION (STATUS, APRIL 1971). Voss, Alfred (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Apr 1971. 53p. Dep. NTIS (U. S. Sales Only).

The cost-optimum capacity distribution of up to 10 different power plants is examined in a national grid under consideration of annual load growth and of various restrictions, e.g., limitation of capacity increase of fast plutonium breeders by limited availability of plutonium. The optimization is carried out for each period of time. Nuclear power plants were exclusively selected according to economic view points. The calculational model is described, and an illustration is given for input and output. (auth)

54140 PRESENT WORTH EVALUATIONS AS AN AID TO NUCLEAR POWER DECISIONS. Searby, P. J. (United Kingdom Atomic Energy Authority, London). Atom (London); No. 178, 185-98(Aug 1971).

Nuclear power is considered as a classic case for investment appraisal, contrasting it with the conventional alternative power sources, and for discounted cash flow analysis. The evaluation of the investment project over time is particularly applicable to the electricity industry as the stations operate over long periods (up to 40 years or more) and have a more or less guaranteed market. The complication of assessment by the diverse nature of cash flows, resulting from the different sources of generation, is discussed in detail and the most reliable methods of assessing a project's worth considered. The development programs and importance of time scale are discussed and explanation of the discounted cash flow system, with reference to differences in growth rate, operating requirements and availability assumptions, given. R and D assessment is also considered. The usual assumption that risk can be accounted for by incorporating it into the discount rate is challenged generally and further questioned with reference to the 1969 Government decision to increase the test rate of discount from 8 to 10%. (UK)

Safety and Siting

Refer also to abstracts 52050 and 54235.

54141 (A/CONF.49/P–27) EXPERIMENTAL WORK ON FAST REACTOR SAFETY. Snepvangers, J. J. M.; Boswinkel, H. H.; van der Kley, N.; (and others) (Reactor Centrum Nederland, Petten). May 1971. 15p. (CONF-710901–74). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A number of fuel pin irradiations were carried out to obtain information about the mechanisms and consequences of pin failures in case of a disturbance in the sodium cooling. In addition experiments were performed to investigate the mode of sodium boiling. Instrumentation was developed for sodium expulsion experiments. The experiments are considered to belong to the class of minor accidents which, if undetected, may hypothetically lead to a major accident by which part of the core will be vaporized. To evaluate this kind of accident, knowledge of the behavior of aerosols in closed systems is required. Investigations on this behavior were carried out at Petten. Different materials were dispersed by the exploding wire technique. The aerosol formation as well as the decay of concentration were studied. 15 references. (auth)

54142 (A/CONF.49/P–150) CANADA JUDGES POWER REACTOR SAFETY ON COMPONENT QUALITY AND RELIABLE SYSTEM PERFORMANCE. Hake, Guest; Barry, P. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.); Boyd, F. C. (Atomic Energy Control Board, Ottawa (Ontario)). May 1971. 13p. (CONF-710901-169). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

For siting and safety of nuclear plants, Canadian authorities base their judgments on upper limits set for (1) radiation exposures in routine and accident situations and (2) plant failure rates and non-availability for safety systems. These factors are given special emphasis in Canada, but approval also requires that the barriers to fission-product release be protected by design margins and safety devices. Component quality is specified in designing a system for a particular level of availability. It is embodied in procurement specifications and checked before installation. However, the attainment of the level of availability must be demonstrated by periodic in-service tests. Severe accidents are postulated, including the simultaneous failure of a process system and a safety system (a "double accident"). Under such conditions, safety devices must limit fuel failures and the shut-down capability keep radiation exposures within the set limits. A description of the environment, including population distribution, plays its usual role in studies leading to site approval, but Canada is now seeking to define a standard site in terms of a statistical diffusion parameter. 15 references. (auth)

54143 (A/CONF.49/P-225) REVIEW OF SAFETY ASPECTS OF NUCLEAR POWER PLANTS IN JAPAN. Ando, Y. (Tokyo Univ. (Japan)); Kawasaki, M.; Suguri, S.; (and others) (Japan Atomic Energy Research Inst., Tokyo). May 1971. 22p. (CONF-710901-90). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Basic studies in Japan on the safety of nuclear structural components such as reactor pressure vessels, piping systems, and containment vessels are summarized. 28 references. (auth)

54144 (A/CONF.49/P-290) UNDERGROUND SITING OF NUCLEAR PLANTS IN NORWAY. Jamne, E. (Institutt for Atomenergi, Kjeller (Norway)). May 1971. 18p. (CONF-710901-262). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A broad program in connection with the siting of nuclear power plants underground is being undertaken in Norway. Results so far show that it is technically feasible to site large commercial nuclear power plants in rock caves. The benefits that can be derived from this method are listed. Economic assessments indicate that only a marginal cost penalty is associated with this method of siting compared to standard siting. Considerable practical experience on various problems in connection with underground construction of nuclear power stations has been accumulated in Norway. Thus the 25 MW(t) power test reactor in the city of Halden, the HBWR, is using rock as primary containment and has been in operation since 1959. The majority of new hydro electric power plants in Norway are also located in rock caves. The research and development program, now underway, aims at an improved understanding of the ability of different kinds of rock to retain fission products, identification of problems connected with the possible contamination of ground water, and the civil engineering limitations in constructing large caverns in different rock structures. Based on the results of this program, further technical and economical assessment of underground nuclear power plant siting will be made with a view to take full advantage of the added safety offered by this method of siting. 2 references. (auth)

54145 (A/CONF.49/P-364) REACTOR SAFETY IN THE FEDERAL REPUBLIC OF GERMANY. Birkhofer, A.; Kellermann, O.; Tscherner, M.; (and others). Apr 1971. 16p. (CONF-710901-124). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Licensing practices in the Federal Republic are most advanced for light water reactors. Safeguards primarily are for the control of basic accidents. For their definition, reliability considerations play an important part. Advantages and limits of the basic accident and the probability concept are discussed and explained by some examples. The permissible maximum risk for the individual person is discussed and compared to the actual exposure at certain incidents. Licensing of light water reactors has been standardized to a great extent and has led to safety criteria. Many of them apply to components of the pressure system. Other items are the design and fabrication of the containment interior, the redundancy and diversity of the emergency cooling system, the design and testing of the containment and penetrations, the internal ventilation, the post accident instrumentation, the pressure suppression system etc. For the high temperature reactor and the fast reactor the criteria are still under development. The requirements for repeated inspections and tests of the plant are explained. Actual incidents of relevance to safety are described. 10 references. (auth)

54146 (A/CONF.49/P-365) SAFETY OF GERMAN DESIGNED LIGHT WATER-REACTORS. Braun, W. (Siemens A. G., Erlangen (West Germany)); Traube, K. (Allgemeine Elektricitaets-Gesellschaft, AEG-Telefunken, Frankfurt am Main (West Germany)). Apr 1971. 20p. (CONF-710901-125). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Design principles and special quality standards of German PWRs and BWRs under construction are reported by which, compared to international practice, the safety against a rupture of the primary coolant system is increased. Further, some specialties of containment design and emergency cooling systems are presented. The efficiency of gaseous and liquid waste-systems is demonstrated by the release rates experienced with operating German light water reactor-plants. Finally, a survey is given of the aims of programs on reactor safety. (auth)

54147 (A/CONF.49/P-475) DESIGN FOR SAFETY OF GAS COOLED REACTORS. Kirk, J. (British Nuclear Design and Construction Ltd. [Whetstone (England)]); Taylor, R. S. (Taylor Woodrow Construction Ltd., Southall (England)). May 1971. 12p. (CONF-710901-148). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The important safety characteristics of the Mk II Gas Cooled Reactors (A.G.R.s) and Mk III Gas Cooled Reactors (H.T.R.s) are described with particular reference to the safety margins inherent in the canning materials and in the large thermal capacities of the graphite moderators. A few typical fault transients are presented to illustrate these properties. The operating Mk I Gas Cooled Reactors (Magnox) have given confidence in the predictions of core physics and fault transient models as accurate design tools for gas cooled reactors. The reactor protection and essential cooling systems are typical of gas cooled reactors requiring high reliability. The design, construction and testing of these systems for the Hartlepool Mk II G.C.R. station are described. The use of the probability approach to safety is discussed as a useful design tool for synthesizing complex systems. It is demonstrated that reliability assessments of such systems are essential to achieve reliabilities which are appropriate to the consequences of their failure and to give consistency of design between systems. The way of choosing the number of guard lines and trip parameters for reactor protection using a reliability assessment is described. Similarly, the number of pumps, valves and pipework sections for one of the essential cooling water systems, described above, is determined by specifying a target failure rate for the total system. The probability approach is of limited value in dealing with the design of mechanical structures. While the required reliability of structures whose failure could be catastrophic can be determined from a probability criterion, actual failure rates are difficult to substantiate because of lack of relevant statistical data. Instead, agreement between designers and safety assessors is essential to arrive at an acceptable design by applying sound engineering principles, model testing, redundancy of components, monitoring for faults and periodic inspection. An illustration of these principles is given by reference to the design, construction and testing of the prestressed concrete pressure vessel. 3 references. (auth)

54148 (A/CONF.49/P-476) DESIGN OF NUCLEAR PLANT WITH INTEGRAL COOLANT CIRCUITS AS RELATED TO THE MAXIMUM CREDIBLE ACCIDENT APPROACH. Coxon, T. (Nuclear Power Group Ltd., Knutsford (England)). Jun 1971. 14p. (CONF-710901-285). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In general throughout the world, the current safety criteria with regard to hazards to the public are based on defined limits to these hazards. By definition therefore, most designs are assessed in relation to a maximum credible accident (M.C.A.) type of approach. The engineering philosophies and data which lead to the design of plant features which then quantify the M.C.A. approach against limiting criteria are discussed. Faults are considered in two categories: those which can be considered highly improbable or incredible, due to basic design provisions and aims, and those remaining, which can be considered credible. In these arguments, the aspects of reliability of plant items and the probability of fault occurrences are considered. The logical development of potential accident sequences is explored and utilized in the analysis taking into account that credible occurrences could happen at any time. Thus, the implications of the M.C.A. approach are illustrated and the necessary engineered features of the design are described. In summary, the integral design concept as defined, can be engineered to meet the various interpretations and definitions of the M.C.A. criteria which exist throughout the world. (auth)

54149 (A/CONF.49/P–477) REACTOR SAFETY PHILOSOPHY AND EXPERIMENTAL VERIFICATION. Farmer, F. R.; Gilby, E. V. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). May 1971. 14p. (CONF-710901–286). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

All reactors are provided with equipment to prevent dangerous situations arising or to modify the potential consequences. For such measures to be effective it must be possible to predict the behavior of the reactor under many conditions and to know whether the equipment supplied has the capability of performing adequately and reliably. On the one hand this requires the systematic use of experience relating to the performance of components and equipment and on the other hand a co-ordinated research and development program to give advanced knowledge in heat transfer, fluid flow, nucleonics, fracture mechanics etc. Ideally the synthesis of safety by design and the analysis by experiment are finally confirmed by some measure of demonstration on the completed reactor. Some examples are described. The first example is concerned with the margins to dryout in the Steam Generating Heavy Water Reactor in the event of flow failure, channel blockage or maldistribution of channel heating. Initial out-of-pile experiments led to confirmatory in-pile dry-out experiments on an actual fuel assembly. This confirmed the substantial margin of safety and showed that dry-out was a more stable and reversible process than might have been expected. The second example is concerned with the possibility of can rupture in a Mk II Gas Cooled Reactor (A.G.R.) following a rapid accidental loss of pressure. In-pile measurements on the rate of rise of can temperature following a slower planned depressurization were combined with out-of-pile observations on the statistical rate of failure of over-heated irradiated cartridges. Together, these provided a convincing picture of the probable result of an actual depressurization on a highly irradiated fuel charge. The third example is concerned with the kinetic behavior of the Prototype Fast Reactor (P.F.R.) which is governed largely by the magnitudes of various reactivity coefficients such as those due to doppler effects and sodium voiding. Experiments in the zero energy fast reactor ZEBRA have reduced the uncertainties in the coefficients and the results will finally be confirmed by experiments during the commissioning of P.F.R. 11 references. (auth)

54150 (A/CONF.49/P–671) DISCUSSION OF NUCLEAR PLANT SAFETY WITH REFERENCE TO OTHER HAZARDS EXPERIENCED BY THE COMMUNITY. Tattersall, J. O.; Simpson, D. M.; Reynolds, R. A. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). May 1971. 14p. (CONF-710901–317). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Nuclear installation safety assessment and the comparison of risk due to the pressure of the installation with the existing hazards facing society are discussed. Reference is made to the continuous trend, particularly noticeable in the evolving technologies such as the aerospace and nuclear industries, of more positive and quantitative evaluation at the design stage. Noting that a probability approach to reactor safety is being actively studied by other workers in the field, the need to define a relationship between the magnitude of an activity release and the probability of the event is examined. Methods for achieving this by consideration of the reactor hazard and the frequency of other hazards normally tolerated by the community are discussed. The problem of detailed evaluation of the reactor design to ensure that it conforms to the limits so established is also mentioned. Recognizing that public acceptance of hazards is continuously changing, the limitations of applying standards accepted in the past to the risks that may arise in the future are already evident. Some mention is made of attempts to overcome this difficulty by consideration of the factors involved in the process whereby society establishes a tolerance level. (auth)

54151 (A/CONF.49/P–672) EARTHQUAKE PROTECTION FOR NUCLEAR REACTORS. Hentschel, G.; Novak, W. (Brown, Boveri and Co., Ltd., Baden (Switzerland)); Orth, F. (Brown, Boveri und CIE A. G., Mannheim (West Germany)). May 1971. 23p. (CONF-710901–318). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The design features of a rocking support for nuclear power plant structures are described. Application of this support concept to an earthquake resistant plant with a gas cooled high temperature reactor is discussed. (H.D.R.)

54152 (BMI–1915) MIRA: METHODS FOR IODINE-REMOVAL ANALYSIS IN REACTOR CONTAINMENT SYSTEMS. Ritzman, Robert L. (Battelle Columbus Labs., Ohio). Aug 1971. Contract W-7405-eng-92. 59p. Dep. NTIS.

A computerized method for analyzing the removal of fission-product iodine from containment-system atmospheres under reactor accident conditions is described in detail. The method considers the simultaneous removal by natural deposition on surfaces or absorption in water, by engineered spray system operations, by flow through filters, and via leakage from the containment system. In addition, the simultaneous behavior of three iodine forms is modeled; specifically, elemental iodine, methyl iodide, and particulate iodine. The computer program is composed of two versions; one which is applicable to a conventional PWR dry containment system, and the other which is applicable to a BWR pool pressure-suppression-type containment system. Both versions are designed to accept containment thermal transient data generated by an independent heat-transfer analysis code. The programming logic is also designed to facilitate subsequent additions or modifications to the analytical models which presently describe the problem. Sample input and output for each version of the program are provided. 23 references. (auth)

54153 (BNWL–1587) REMOVAL OF AIRBORNE FISSION PRODUCTS BY RECIRCULATING FILTER SYSTEMS IN THE CONTAINMENT SYSTEMS EXPERIMENT. McCormack, J. D.; Hilliard, R. K.; Postma, A. K. (Battelle Pacific Northwest Labs., Richland, Wash.). Jun 1971. Contract AT(45-1)-1830. 128p. Dep. NTIS.

Five large-scale demonstration tests were carried out in the 26,500 cubic foot Containment Systems Experiment vessel, using an internal recirculating filter loop to remove airborne fission product simulants. Loop components were nominal 2 ft by 2 ft, commercially available units including a heat exchanger, demister, roughing filter, high efficiency particulate filter, and impregnated charcoal adsorbers. Flow through the loop was either 1000 or 1800 CFM and in four of the tests the containment atmosphere was saturated steam-air at 250°F, 48 psig. This system performed satisfactorily, removing both particulate and gaseous fission products, including methyl iodide. Elemental iodine was removed initially at a rate somewhat faster than predicted for 100% efficiency, due to wall deposition. Particles were removed with an efficiency of 100%, and methyl iodide with an efficiency of 80%. At long times, the airborne concentration of all fission products approached equilibrium levels equivalent to decontamination factors greater than 10,000. (23 references) (auth)

54154 (BNWL–1591) EFFECT OF SPRAY FLOW RATE ON WASHOUT OF GASES AND PARTICLES IN THE CONTAINMENT SYSTEMS EXPERIMENT. Hilliard, R. K.; Postma, A. K. (Battelle Pacific Northwest Labs., Richland, Wash.). Jul 1971. Contract AT(45-1)-1830. 64p. Dep. NTIS.

The results of a large-scale containment spray experiment are reported in detail. This experiment was performed in the 26,500 cubic foot Containment Systems Experiment (CSE) vessel in a steam-air environment. The spray flux was 0.3 gal/min per ft^2 which is higher than that of current PWR containment system designs. All of the fission product simulant materials were washed out very rapidly with the exception of methyl iodide. Correlation of these results with those of earlier experiments showed that the initial removal rates of elemental iodine vapor and cesium and uranium particles were nearly linear with spray flow rate over the range of conditions investigated. (18 references) (auth)

54155 (BNWL–1592) CONTAINMENT SYSTEMS EXPERIMENT FINAL PROGRAM SUMMARY. Postma, A. K.; Johnson, B. M. (Battelle Pacific Northwest Labs., Richland, Wash.). Jul 1971. Contract AT(45-1)-1830. 104p. Dep. NTIS.

A technical summary of the Containment Systems Experiment (CSE) Program is presented. The program was directed toward obtaining data in support of safety analyses on the transient response of several aspects of the reactor containment system during and following a loss of coolant accident. Emphasis was placed on the study of fission product transport and removal in the containment structure, and on fluid behavior in the reactor vessel during the blowdown event. The scale of these experiments was approximately a one fifth linear scale of a 1000 MW(e) nuclear reactor. Data was obtained on methods of detecting and measuring leakage from large containment systems; on fission product removal (following a simulated major release resulting from a loss of coolant accident) via natural deposition, spray action, and recirculation of the containment atmosphere through a cleanup sys tem; and on fluid behavior in the reactor vessel during blowdown. 23 references. (auth)

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54156 (DOCKET-RESARA-3) [WESTINGHOUSE NUCLEAR STEAM SUPPLY SYSTEM]. Reference Safety Analysis Report, Revision I, Volume 1. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). 15 Sep 1971. 338p. Dep. NTIS.

Information required in Preliminary Safety Analysis Report for U. S. power reactors is presented under the following broad topics: reactor design characteristics; and reactor cooling system. (D.C.C.)

54157 (DOCKET-RESARA-4) [WESTINGHOUSE NUCLEAR STEAM SUPPLY SYSTEM]. Reference Safety Analysis Report, Revision I, Volume 2. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). 15 Sep 1971. 350p. Dep. NTIS.

Information required in Preliminary Safety Analysis Report for U. S. power reactors is presented under the following broad topics: engineered safety features; instrumentation and control; and auxiliary systems. (D.C.C.)

54158 (DOCKET-RESARA-5) [WESTINGHOUSE NUCLEAR STEAM SUPPLY SYSTEM]. Reference Safety Analysis Report, Revision I, Volume 3. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). 15 Sep 1971. 390p. Dep. NTIS.

Information required in Preliminary Safety Analysis Report for U. S. power reactors is presented under the following broad topics: initial tests and operations; safety analysis; quality assurance program; and quality control tests. (D.C.C.)

54159 (IN-ITR-108) MEASUREMENTS OF THE REACTION OF UO_2 WITH WATER FOR TRANSIENT ENERGY DEPOSITIONS TO 550 CAL/G OF UO_2. Olsen, C. S. (Idaho Nuclear Corp., Idaho Falls). Nov 1969. Contract AT(10-1)-1230. 33p. Dep. NTIS.

Transient tests were performed in the Capsule Driver Core on 10%-enriched UO_2, glass clad fuel rods. The primary objective of these tests was to determine the extent of the UO_2-water reaction under conditions of a rapid dispersion of molten fuel into water. The fuel rods were placed in a capsule containing water at ambient temperature and subjected to power bursts with nuclear energy depositions ranging from 330 to 550 cal/g of UO_2. The hydrogen release (cc of H_2/g of UO_2) varied from 5.32 cc/g at 330 cal/g of UO_2 to 14.32 cc/g at 550 cal/g of UO_2. The maximum hydrogen release corresponds to an oxidation product with an oxygen–uranium ratio of 2.161. 8 references. (auth)

54160 (NEDO-10349) ANALYSIS OF ANTICIPATED TRANSIENTS WITHOUT SCRAM. Michelotti, L. A. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Mar 1971. 44p.

The consequences of the failure of a BWR scram protection system are evaluated. Potential design innovations to ease the severity of the consequences of the failure-to-scram are identified. (auth)

54161 (ORNL-TM-3546) PRELIMINARY EVALUATION OF AN ASSUMED CORE MELTDOWN ACCIDENT IN A 1000 MW(e) GAS-COOLED FAST BREEDER REACTOR. Holcomb, R. S. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 26p. Dep. NTIS.

The consequences of the meltdown of the core of a 1000 MW(e) gas-cooled fast breeder reactor are evaluated and methods for containing and cooling the molten core are presented. Three methods are considered: spreading the material in a thin layer and cooling from one side, collecting the material in narrow vertical passages cooled from both sides, and collecting the material as a pool in the reactor vessel with cooling on all surfaces. The third method appears to be the most attractive from a cost and structural standpoint. It is estimated that if the vessel liner cooling water capacity were increased to 16,000 gpm the molten material could be contained within the vessel liner. If the vessel liner were insulated with a 6-in. thick layer of graphite on the floor and 3 ft of the sidewall, the required cooling capacity would be 11,000 gpm. (7 references) (auth)

54162 (TID-25603(Suppl.)) PUERTO RICO ENERGY CENTER STUDY. SITE SELECTION SUPPLEMENT. (Burns and Roe, Inc., New York. Dow Chemical Co., Midland, Mich.). Jul 1970. 157p. Dep. NTIS.

Preliminary site requirements were compiled and tentative layouts were prepared for each proposed site. The site requirements were updated in keeping with developments in the industrial and agricultural studies. Site layouts were made. Descriptions of each site were prepared covering geology, seismology, hydrology, agronomy, demography, meteorology, transport, finance and socio-economics. Estimates of the relative capital cost of the sites were prepared including cost of acquiring the land and buildings, levees for flood protection, land filling and compaction, pump stations where required, harbor dredging, electrical transmission lines, power plant foundations and circulating water system. Operating costs were capitalized for pumping stations and for the cost of industrial water. The total relative estimated costs for capital and capitalized operating costs indicated the Aguirre area was lower in cost than Guayanilla and the Arecibo site exceeded both by a wide margin. On the basis of the general undesirability as well as costs, Arecibo was dropped from further consideration. Qualitative factors were compared for Guayanilla and Aguirre including land availability, meteorological safety, conservation aspects and agronomical considerations. (auth)

54163 (WCAP-7750) COMPREHENSIVE SPACE-TIME DEPENDENT ANALYSIS OF LOSS-OF-COOLANT (SATAN-4 DIGITAL CODE). Bordelon, Frank M. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). Aug 1971. 77p.

A comprehensive model of the reactor coolant system is presented. It is able to treat all phases of the loss-of-coolant accident and it could also be applied to the simulation of other transients. Fluid conditions may be subcooled, two-phase or superheat in any part or all of the system. Flow reversals are allowed at any location. Feedback effects are incorporated in the analysis. Pump coast down and cavitation, core and steam generator heat flow including DNB, reactivity insertion resulting from voids, and doppler effects are included. The geometrical model is variable and hence able to simulate non-standard reactor systems as well as various experimental apparatus. The model has been applied to available experimental data and the agreement is satisfactory. The applicability of the analysis would be further extended by the addition of steam separation calculations. 22 references. (auth)

54164 POWER GENERATION AND THE ENVIRONMENT. Eliassen, Rolf (Stanford Univ., Calif. Metcalf and Eddy, Inc., Palo Alto, Calif.). Proc. Nat. Acad. Sci. U. S. A.; 68: No. 8, 1938-43(Aug 1971).

Environmental factors will play an ever-increasing role in planning for the location and design of future power generating plants. This planning must include all phases of furnishing electric power, such as the exploration for and mining of fossil and nuclear fuels; the transportation and storage of these fuels; power plant siting; the disposal of solid wastes from power plants; and the transmission and distribution of electric power. Systems analysis will be of assistance in realistic decision-making and planning. Simulation models can be used to evaluate social, economic, and technological inputs, in order to reach engineering decisions that will assure meeting reasonable environmental standards. Management must look beyond the metropolitan areas presently served by specific electric utilities and must adopt new concepts of both urban and regional planning that will help meet the electric power requirements in the decades ahead and minimize adverse effects on the air, water, and land environment. 7 references. (auth)

54165 SAFETY OF NUCLEAR REACTORS. Palladino, Nunzio J. (Pennsylvania State Univ., College Park). pp VI.1-20 of Nuclear Power and the Environment. Madison, Wis.; Univ. of Wisconsin (1970).

From Conference on nuclear power and the environment; Madison, Wis. (3 Apr 1970). See CONF-700415.

Basic concepts of reactor safety are discussed, and engineered safeguards used to limit the effects of potential accidents are described. The licensing and regulatory process for nuclear power plants in the U. S. is briefly examined. (H.D.R.)

54166 STRUCTURAL MECHANICS IN REACTOR TECHNOLOGY. VOL. 4. REACTOR PLANT STRUCTURES AND CONTAINMENT. PART K. SEISMIC RESPONSE ANALYSIS OF NUCLEAR POWER PLANT SYSTEMS. Preprints of the First International Conference, Berlin, Germany, 20–24 September 1971. Jaeger, Thomas A. (comp.). Luxemburg; Commission of the European Communities (1971). 238p. (CONF-710903-(Vol.4)(Pt.K)).

Included are 13 papers on methods for analysis of soil-structure interactions and the response of nuclear power plant structures to seismic motion. (H.D.R.)

54167 STUDIES ON SODIUM BOILING ACCIDENTS IN A LARGE FAST BREEDER REACTOR. II. RADIAL PROPAGATION OF SODIUM BOILING BY REACTIVITY EFFECT. Nagashima, Kunio; Tezuka, Masaji (Nippon Atomic Industry Group Co., Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 8: No. 7, 382-93(Jul 1971).

A computer code BORE was developed, with which analyses were performed on channel plugging accidents that would occur on a 1,500 MW(e) LMFBR. The BORE code calculated the dynamic characteristics of coolant boiling and fuel failure propagation radially in the core, and the requirements of core instrumentation systems were also analyzed. The results show that coolant boiling and/or fuel failure in a channel plugging accident are propagated only to a limited number of adjacent channels when sensors are installed that detect anomalies in channel flow, channel outlet temperature, boiling or reactivity. It is also concluded that the coolant void effect is not serious from the standpoint of safety when the time required for boiling propagation to adjacent channels can be made longer than 0.15 sec. 8 references. (auth)

54168 STUDIES ON THE LOSS-OF-COOLANT ACCIDENT IN WATER-COOLED NUCLEAR POWER REACTORS. 3. Nishiwaki, Ichiro; Shimizu, Sadaaki; Inami, Kuniaki; Kasuga, Yasuhiro (Electrotechnical Lab., Tokyo). Denshi Gijutsu Sogo Kenkyusho Iho; 34: No. 7, 540-71(Jul 1970). (In Japanese).

The blowdown test facility was used to develop information on core-heatup phenomena associated with a loss-of-coolant accident in water-cooled nuclear power reactors. The research program consists of blowdown and core-heatup experiments during the loss-of-coolant accidents. The entire primary coolant system includes both BWR and PWR loops. Instrumentation is provided to measure the transient thermal behavior of the electrically heated reactor core. Parametric blowdown tests were performed to evaluate the influence of the break size and the break location on the transient core-heatup phenomena during the blowdown. The major experimental results are stated as follows: (1) Top blowdown experiments show that the time required for uncovering the reactor core is shorter for large break as compared with that for small break, and that the clad temperature after uncovering is relatively high for larger break. (2) Bottom blowdown experiments indicate the reverse situations as compared with the top blowdown ones, namely, the time required for uncovering is rather shorter and the clad temperature is relatively high in the case of smaller break. These results are mainly attributed to the phase-separation phenomena in the reactor vessel, that is, the separated steam during the bottom blowdown is likely to be accumulated in the top portion of the core and this possibly makes the faster uncovering of the core as compared with that for the blowdown. Simulated double-ended blowdown experiments show that the transient thermal response of the reactor core for the double-ended blowdown is similar to that for the top blowdown. This result indicates that heat removal from the reactor core during the double-ended blowdown is mainly predominated by the behavior of the coolant discharged from the top break located close to the outlet nozzle of the reactor vessel. (auth) (Japan)

Power Conversion Systems

54169 (A/CONF.49/P-582) POWER INCREASE WHICH CAN BE ACHIEVED WITH CERTAIN REACTORS BY HEAT PUMPING AND ACCUMULATION. Pacault, P.; Mary, F.; Gaussens, J. (Societe Babcock-Atlantique, Paris (France)). Apr 1971. 18p. (In French). (CONF-710901-246). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The process allows the primary circuit of a P.W.R. to be maintained at full rating, while during the whole full load time and without any appreciable loss of efficiency, it generates about 1.8 times more power than at low load time. To do this, a fraction of the steam generated a low-load time passes through a compressor coupled to the turbines. It is then desuperheated, condensed and subcooled in a heat exchanger G, until it reaches the temperature of the feedwater, with which it is mixed after throttling. The exchanger G is used to heat a medium at atmospheric pressure, divided into two loops. The first closed loop passes through an exchanger S, designed to dry and superheat the exhaust steam from the H.P. turbine. The second closed loop passes through an accumulator, composed of stacked elements specially arranged for storing a specific part of the heat content of the medium. At low-load time, the power of the generator is thus reduced because of the smaller steam flow through the turbine and the need to drive the compressor. At full load time, the compressor and exchanger G are stopped. The circuit of the medium is reversed in the accumulator, and coils through the single exchanger S which in this way receives the accumulated heat. The available electric power is greatly increased, as the turbine receives the full steam flow, and the L.P. steam is dried and reheated by the accumulator and heat exchanger S. Furthermore, in emergency conditions, the heat reserve provided by the accumulator allows the operation of the main auxiliary equipments by steam turbines. (auth)

54170 NUCLEAR POWER STATIONS. George, Brian Victor; Appleby, John Rand (to British Nuclear Design Construction Ltd.). British Patent 1,241,811. 4 Aug 1971. Filed 14 Mar 1968.

Reference is made to nuclear power stations of the type employing a fluid cooled reactor supplying heat to a unit for generating steam from pressurized water for use with a steam turbine. During required power output changes with such a system changes may occur in the temperature of the steam at admission to the turbine nozzles, and with turbines utilizing very high pressure and temperature steam large changes of steam temperature downstream of the throttle valves will, if occurring rapidly, give rise to significant thermal gradients, and differential thermal expansion, in the structure comprising the inlet section of the turbine, causing strains and stresses in the affected structures, possibly leading to failure. In the system described provision is made to vary the temperature of the reactor coolant circuit and/or the steam pressure upstream of the turbine throttle valve, in response to power demand signals, in such a manner that the steam temperature downstream of the throttle valve is maintained within acceptable limits. Where canned fuel elements are employed, this temperature is adjusted so as to maintain the differential strain cycles that would normally be induced in the fuel elements as a result of changes in power output, also within acceptable limits. The application of this system to the operation of a typical nuclear power station employing an advanced gas-cooled reactor is described in detail. (UK)

Research and Test Reactors

Refer also to abstracts 51684, 51737, 53912, 53920, 53988, and 54136.

54171 (70-CNA-616) NPD OPERATION DURING THE PAST YEAR (APRIL 30, 1969–APRIL 30, 1970). Hayter, D. M. (Hydro-Electric Power Commission of Ontario, Toronto). 7p. (CONF-700564-8). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

NPD achieved a net capacity factor of 44% for the period, with the heavy water heat transport system operating in the boiling mode. A leak in the main heat exchanger and attempts to remove a sample of the leaking tube caused most of the forced outage production losses. During the period improved fueling machine heads and fueling controls were installed and have operated very successfully. (auth)

54172 (A/CONF.49/P-3) EXPERIMENTS AND OTHER ACTIVITIES WITH GRR-1. Chrysochoides, N. G.; Mitsonias, C. A.; Papastergiou, C. N.; Perricos, D. C. (Democritus Nuclear Research Center, Athens (Greece)). May 1971. 14p. (CONF-710901-60). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Some of the basic and applied research projects performed with the Democritos reactor and the solution to practical problems like the increase of the reactor power to 5 MW, the handling of very radioactive materials, and the organization of a group of specialists to face the various problems arising from the installation of a nuclear power station are described. 20 references. (auth)

54173 (A/CONF.49/P-11) ADVANCED RESEARCH USES OF THE ISRAEL RESEARCH REACTOR IRR-1. Yiftah, S.; Amiel, S.; Ben-David, G.; (and others) (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). May 1971. 20p. (CONF-710901-64). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Some present advanced research uses of the IRR-I are summarized. Specifically the following research projects are briefly analyzed: (1) SOLIS—Soreq on line isotope separator; (2) Gamma resonant scattering; (3) Inelastic neutron scattering; (4) Radiation damage research; and (5) Polarized neutrons. 25 references. (auth)

54174 (A/CONF.49/P-20) KEMA SUSPENSION TEST REACTOR. Went, J. J.; Hermans, M. E. A. (Keuring van Electrotechnische Materialen, N. V., Arnhem (Netherlands)). May 1971. 19p. (CONF-710901-70). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Apart from fuel salt solutions or molten salts, aqueous fuel suspensions based on the ^{233}U-Th cycle could be used in homogeneous liquid fuel reactors. The possibilities and limitations of the aqueous suspensions have been studied extensively for this purpose. On the basis of the results of these studies a 1 MW(t) facility has been constructed to explore the dynamic behavior of a reactor system operating with different types of fuel suspensions. The facility is described with its experimental possibilities and its program. Several specific features and technical and fundamental limitations of the application of different suspensions are discussed on the basis of existing knowledge and experience with non-critical loops. (auth)

54175 (A/CONF.49/P-280) UTILIZATION OF THE MATERIAL TESTING THERMAL REACTOR BR2 FOR FAST NEUTRON IRRADIATIONS. Debrue, J.; DeRaedt, Ch.; Lenders, H.; (and others) (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). May 1971. 23p. (CONF-710901-104). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The high flux thermal reactor BR2 is utilized for the irradiation of fast reactor fuel. The rigs devised for the irradiation of fast reactor fuel pins are described. The irradiations are performed under cadmium screens either in capsules with stagnant NaK or in loops with forced sodium circulation. The irradiation conditions obtained are described and compared to those existing in the fast reactors as to the fission density, the radial power depression in the pins, the neutron spectrum, the burnup rate in the irradiated fuel, and the damage suffered by the cladding material. Modifications which can easily be brought to the BR2 reactor are evaluated (optimized fuel elements, power increase, loop concept) with a view to creating such new irradiation conditions that the ratio of the damage suffered by the cladding material to the burn-up rate of the irradiated fuel be nearer to that obtained in the fast reactors. 18 references. (auth)

54176 (A/CONF.49/P-326) ROLE OF A RESEARCH REACTOR IN SCIENCE TECHNOLOGY AND EDUCATION IN HUNGARY. Szabo, F.; Csom, Gy.; Oerdoegh, M.; Szabo, E.; (and others) (Central Research Inst. for Physics, Budapest). Jun 1971. 16p. (CONF-710901-274). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The range of influences exerted by the Institute's research reactor on the development of basic research in the Institute is discussed. The provision of a research reactor was instrumental in initiating research in the fields of nuclear chemistry and reactor physics and hastened the development of the nuclear physics and electronics research. The devices and methods originally developed in the fields of reactor physics and nuclear physics coupled with the nuclear chemical know-how were rapidly brought into an applied research program and were successfully adapted into the production of semi-conductors, steel-making and the refining of nonferrous metals. The financing of the different stages of this program is also given. The experiences gained at the Institute's research reactor in helping the design of a reactor construction suitable for the intended educational and research program are reviewed. Since it must fulfill the needs of several universities, the characteristic feature of this reactor is that it has to support a complex educational program as well as ensure wider research possibilities. 8 references. (auth)

54177 (A/CONF.49/P-344) UTILIZATION AND THE ROLE OF THE RESEARCH REACTOR FOR THE NUCLEAR TECHNOLOGY DEVELOPMENT IN ROMANIA. Hulubei, H.; Udrea, I.; Stoian, D.; Petrascu, M.; (and others) Jun 1971. 20p. (CONF-710901-277). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The operations history for the WWR-S reactor in Romania is reviewed. Design modifications for the reactor are described. Research programs and radioisotope production are discussed. 80 references. (D.C.C.)

54178 (A/CONF.49/P-348) EXPERIENCES IN UTILIZATION OF RESEARCH REACTORS IN YUGOSLAVIA. Copic, M.; Gabrovsek, Z. (Institut Jozef Stefan, Ljubljana (Yugoslavia)); Pop-Jordanov, J.; Raisic, N. (Boris Kidric Institute, Belgrade). May 1971. 8p. (CONF-710901-115). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

At the nuclear institutes in Yugoslavia there are three research reactors. Since 1958 at the Boris Kidric Institute two heavy water reactors have been in operation, a zero power reactor RB and a 6.5 MW reactor RA. At the Jožef Stefan Institute a 250 kW Triga Mark II reactor has been in operation since 1966. The reactors are equipped with necessary experimental facilities. The main activities covered by these reactors are: fundamental research in solid state and nuclear physics; R and D activities related to nuclear power programe; and radioisotope production. 17 references. (auth)

54179 (A/CONF.49/P-485) UTILISATION OF BRITISH UNIVERSITY RESEARCH REACTORS. Duncton, P. J. (Fairey Co. Ltd., Heston (England)); Bridge, H. (Liverpool Univ. (England). Manchester Univ. (England)); Edwards, J.; (and others) (Royal Naval Coll., Greenwich (England)). May 1971. 11p. (CONF-710901-150). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Relevant British experience relating to the employment of university research reactors and sub-critical assemblies in the education of nuclear scientists and technologists, in the training of reactor operators and for fundamental pure and applied research in this field is reviewed. The facilities available in a number of British universities and the uses which have been made of them for undergraduate training and for postgraduate and postdoctoral research are described. Reference is made to the possibilities of work in collaboration with industrial, medical and other nuclear establishments and laboratories. Statistics are given not only of the size of the various departments and of the throughput of students, but also of the division of reactor operating time between the various types of work and classes of user. These latter have included physicists, engineers, chemists, metallurgists, geologists and several classes of biologists. Increasing attention is being given to the possibility of providing an activation analysis service and of the local production and use of short-lived radioisotopes. Concise details are given of the nature and results of a typical range of research projects which have been carried out in the university laboratories. 48 references. (auth)

54180 (A/CONF.49/P-486) USE OF RESEARCH REACTORS IN THE U.K. FOR NEUTRON BEAM STUDIES OF CONDENSED MATTER. Low, G. G. (Atomic Energy Research Establishment, Harwell (England)); Mitchell, E. W. J. (Reading Univ. (England). J. J. Thomson Physical Lab.). May 1971. 8p. (CONF-710901-151). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Neutron beam research is carried out at the U.K. Atomic Energy Authority Research Reactors at Harwell and Aldermaston. The neutron beam experiments presently mounted at U.K. reactors are: DIDO (Harwell) with two twin rotor time-of-flight spectrometers, one with a liquid hydrogen source, a 3-axis spectrometer and six 2-axis spectrometers for diffraction measurements; PLUTO (Harwell) with a twin rotor time-of-flight spectrometer, a 3-axis spectrometer, two polarized neutron spectrometers, three spectrometers for measurements of diffuse scattering (from, for example, defects) and three 2-axis spectrometers for diffraction; and HERALD (Aldermaston) with two instruments for defect studies, one with a liquid hydrogen-deuterium source, two 2-axis spectrometers for diffraction and two time-of-flight instruments, one also on the above cold source. A number of examples illustrating the range of recent experiments are given: among these are measurements of defect scattering at long wavelengths and studies of molecular energy levels by inelastic neutron scattering. 30 references. (auth)

54181 (A/CONF.49/P-559) ROLE OF RESEARCH REACTORS IN THE ARGENTINE NUCLEAR PROGRAM. Cosentino, Jorge Oscar (Comision Nacional de Energia Atomica, Buenos Aires (Argentina). Gerencia de Energia). May 1971. 8p. (In Spanish). (CONF-710901-490). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A description of the research reactors existing in Argentina is given. The program of utilization of these reactors is analyzed together with its relation to the Argentine nuclear program. The connection with the Argentine program for power reactors is particularly emphasized. (auth)

54182 (A/CONF.49/P-580) TESTS ON NUCLEAR FUEL SAFETY CARRIED OUT ON THE PEGASE REACTOR. Lurie, R.; Housseaux, O. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires); Souch, A. E. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.); Dodds, R.; (and others) (United Kingdom Atomic Energy Authority, Chapelcross Works). Jun 1971. 15p. (CONF-710901-399). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The safety experiments carried out in the nuclear fuel testing pile PEGASE are described. They are divided into two categories: fuel resistance tests under abnormal conditions, to define the limits of use of this fuel and consequently to increase the yield of power piles without prejudice to their safety; and tests aimed at improving the conditions of detection of events liable to compromise seriously the working condition of a power reactor. (auth)

54183 (A/CONF.49/P-591) USE OF SILOE REACTOR IN PROMOTING NUCLEAR TECHNIQUES CO-OPERATION WITH OTHER COUNTRIES. Merchie, F.; Rossillon, F. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr 1971. 15p. (In French). (CONF-710901-247). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The SILOE reactor is used for both fundamental and applied research and has a major part to play in the development of nuclear techniques. Ever higher performances are being sought to meet the needs of experimenters whose work is increasing in complexity and requires increasingly high thermal or fast flux intensities. The variety of research and experimental programs carried out in the neutron, hydraulic and thermal fields has led to improved familiarity with this type of reactor and enabled relatively high power densities to be obtained. Parallel development of increasingly sophisticated fuel elements is the outcome of research into new production techniques. A complete range of advanced experimental systems has been developed around this reactor. Some of their applications are as follows: resonance cavity determination of changes in the length or diameter of metallurgical specimens under conditions of creep, or of uranium or plutonium-based fuel samples, with parallel analysis of the relevant fission products; and production of high temperatures for thermionic conversion experiments. The experiments are controlled and monitored by an on-line computer which can handle 500 measuring channels. Development of non-destructive testing techniques based on neutrography has made particularly rapid strides and valuable results have been obtained with regard to cold neutron testing of very thick steels. Work programs developed around this reactor involve successful co-operation with a number of countries, especially the developing countries, in the fields of training and development of reactors and experimental systems. (auth)

54184 (A/CONF.49/P-593) IRRADIATION FACILITIES FOR SPECIALIZED RESEARCH. Millies, P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires); Saulnier, A. (Societe Industrielle de Combustible Nucleaire, Veurey (France)). Jul 1971. 19p. (CONF-710901-443). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The most advanced systems and techniques developed by the various departments of the Commissariat à l'Energie Atomique with the help of industry are described. Included are continuous equipment for monitoring of axial transverse dimensional changes of structural materials and fuels (creep, swelling, expansion, etc...); an irradiation loop at the temperature of liquid neon; a high temperature furnace using high frequency control; a high power irradiation loop utilizing circulating liquid sodium and heat pumps; a high temperature loop using helium circulation, and a gas loop for radiochemical research. Techniques include continuous monitoring of deformation (hyperfrequency); testing seals and Na level, using eddy currents; and heat barrier fabrication processes: flame spraying and casting of molten metals. (auth)

54185 (A/CONF.49/P-594) FRANCO-GERMAN HIGH-FLUX REACTOR HISTORY AND CONSTRUCTION. Chatoux, J.; Bregeon, L.; Schwartz, J. P. (Commissariat a l'Energie Atomique, Paris (France)); Reutler, H.; (and others) (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). Jul 1971. 18p. (CONF-710901-444). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The design of the High Flux Reactor of the Franco-German Institute Max von Laue-Paul Langevin is based on a compact annular cylindrical core. It is externally moderated from one side of the heavy water in a reflector vessel, where safety rods act as a shutter between core and reflector, and from the other side, by the heavy water of the central cavity, which is large enough to allow control rod insertion. Channels are provided to extract neutrons of various grades from the reflector. The maximum available flux is 1, 5.10^{15} n/cm^2.s for a total power of 57 MW. A liquid deuterium source and a very hot graphite source characterize several channels. The same heavy water flows through the core and the reflector. The whole vessel is in a pool, allowing for reloading and disassembling. Experimental and operational areas are at different levels independently ventilated. The whole facility is enclosed in a double-walled containment, with intermediate pressurization. 6 references. (auth)

54186 (A/CONF.49/P-655) RESEARCH PROGRAM AT THE IRR-2. Bar-Or, A.; Degani, N.; Gvion, R.; Moreh, R.; (and others) (Nuclear Research Centre-Negev, Beer-Sheba, Israel). May 1971. 20p. (CONF-710901-311). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Research performed at the IRR-2 reactor is reviewed. The research includes studies of irradiated fuel elements, comparative studies of the radiosensitivity of tissue cultures to different types of radiations, isotope productions, nuclear levels via nuclear photoexcitation, and magnetic structures of various compounds via neutron diffraction. 17 references. (auth)

54187 (A/CONF.49/P-720) USE OF THE MP RESEARCH REACTOR FOR TESTING FUEL ELEMENTS AND MATERIALS FOR THE POWER REACTOR. Goncharov, V. V.; Ryazantsev, E. P.; Kruglov, A. B.; Goncharov, L. A.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 25p. (CONF-710901-482). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The problems of using the MP Materials Testing multiloop reactor for needs of atomic power industry are discussed. The means of extending the MP reactor experimental potentialities and increasing the reactor efficiency in developing testing and investigations in loops of experimental fuel assemblies, materials and the working parameters of developing nuclear power reactor primary circuits are described. The conditions are now provided in the MP reactor for simultaneous testing at ten loop facilities in 20-25 experimental channels. A new MP reactor core, some loop facilities and methods of reactor experiments in pressurized water and boiling coolant with high weight % of vapor, are described. The methods of improving conditions for testing fuel assemblies and materials in MP reactor and loop facilities are discussed. Results of testing sintered Zr alloy clad UO_2 fuel assemblies are presented. (auth)

54188 (A/CONF.49/P-732) EXPERIMENTAL REACTORS IN SPAIN. Vigon, M. A.; Montes, J.; Manas, L.; Verdaguer, F.; (and others) (Junta de Energia Nuclear, Madrid (Spain)). May 1971. 7p. (In Spanish). (CONF-710901-503). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Spain has five experimental reactors: Two swimming pool reactors JEN-1 and JEN-2, a fast reactor CORAL-1, and two Argonant-type reactors ARGOS and ARBI. In the description of the main applications of these reactors special attention will be given to those aspects whose contribution to the nuclear science and technology has been more effective. 39 references. (auth)

54189 (A/CONF.49/P-774) (IBR-2) REACTOR, REACTIVITY PULSE DEVICE DESIGN AND ITS OPTIMIZATION. Ananjev, V. D.; Blokhintsev, D. I.; Bondarenko, V. V.; Bulkin, Yu. M.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 19p. (CONF-710901-426). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The pulsed fast reactor with injector (IBR-2) which will be built at the Joint Institute for Nuclear Research (Dubna) is designed as a multipurpose unit for performing experiments in nuclear physics, solid state physics and several applied branches with the use of flight time spectrometry. The main requirement to the source of this type is to provide high neutron intensities on wide energy scale beginning from fractions of ev up to hundreds of kev with the pulse duration in the range from 1 to 100 msec. The most rational solution of this problem is to build a unit consisting of a pulsed fast reactor with high current electron accelerator-injector the target of which is in the core of the reactor. The pulsing of the reactor is provided by periodical change of the reactivity of the system achieved by transference of the movable part of the reflector regarding the core. The results of neutron and physical calculations of the reactor are given, as well as the justification for the reactor parameters from the point of view of physics, heat engineering, limitation in solidity and experimental requirements. The pulse characteristics of IBR-2 reactor for reactor and booster regime are considered. The designs of the main units of the reactor are given including the core, reactor vessel, target channel, stable and movable reflectors, moderator blocks, biological shielding. The problems connected with kinetics, control and safe work of the reactor are discussed. 6 references. (auth)

54190 (A/CONF.49/P-776) EXPERIENCE OF D.R.C. CONCERNING THE DEVELOPMENT OF A RESEARCH REACTOR IN THE TRICO NUCLEAR CENTER. Malu, Felix; Congo, R. D. Apr 1971. 10p. (In French). (CONF-710901-512). Dep. NTIS (U. S. Sales Only).

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Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The experience gained during the construction, operation and utilization of a research reactor in the TRICO Nuclear Centre in Democratic Republic of Congo is described. The experience gained during construction is certainly important for the daily running, operational programs, and future development. The current efforts which are made in order to transform the TRICO Nuclear Centre into a regional Centre for benefit of all African countries are presented. (auth)

54191 (A/CONF.49/P–787) THE PRR-1 AND DEVELOPMENT OF ATOMIC ENERGY IN THE PHILIPPINES. Afable, Pedro G. (Philippine Atomic Energy Commission, Manila); Ibe, Librado D. (Philippine Atomic Research Center, Manila). May 1971. 9p. (CONF-710901–329). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The Philippine Research Reactor (PRR-1) is an open pool type obtained by the Philippine Government under its Bilateral Agreement with the United States. It attained criticality in August 1963 and operated at full power of one megawatt a year later. Since the attainment of criticality, PRR-1 has been used particularly in the production of radioisotopes; studies in nuclear science and engineering; and training of the PAEC personnel, university faculty, science teachers, engineers and scientists of public and private institutions, and graduate students in nuclear science and technology. In radioisotope production mainly short- and medium-half-life isotopes are produced. These are in great demand by local medical practitioners as well as by researchers in agriculture and industry. Another PAEC activity utilizing PRR-1 is the provision of technical services to research and industrial institutions. Projects such as mercury inventory in electrolytic cells, determining clogged or leaking pipelines, and hydrographic studies of Manila Bay were made using radioisotopes produced from PRR-1 Neutron activation analysis is now an accepted method of trace elemental analysis of mineral ores. The PRR-1 also served as the principal equipment in the India-Philippines-International Atomic Energy Agency (IPA) project. This regional cooperative project in neutron spectrometry research was conducted from 1964 to 1969 with 14 participants from Indonesia, Korea, Taiwan, Thailand, and the Philippines. PAEC looks forward to the early establishment of a nuclear power plant in the country as well as the utilization of large radiation sources. Towards this end, greater utilization of PRR-1 for training nuclear power plant personnel is expected. (auth)

54192 (A/CONF.49/P–820) ADVANCED RESEARCH REACTOR USES FOR BASIC RESEARCH IN JAPAN. An, Shigehiro; Kihara, Hiroshi (Tokyo Univ. (Japan)); Kimura, Motoharu (Tohoku Univ., Sendai (Japan)); Okamura, Seizo; (and others) (Kyoto Univ. (Japan)). May 1971. 16p. (CONF-710901–342). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Nuclear Engineering Research Laboratory of Tokyo University has established the Fast Neutron Source Reactor (YAYOI) (2 kW, fast reactor), to perform research in the field of fast and intermediate neutron. YAYOI has the following original features to enhance the flexibility and the originality of research, a horizontally movable core assembly, a neutron field of fast, intermediate and thermal energy spectrum can be obtained by moving the core assembly, and pulsed and modulated neutron fields can be provided using accelerators in combination with the reactor. At present, Research Reactor Institute of Kyoto University is operating 5 MW tank type reactor (KUR). The research work using KUR is as follows: neutron physics study with various choppers, reactor physics with thermal columns, neutron diffraction study, low temperature irradiation study, activation analysis, radiochemistry, and radiation biology. Recently the preliminary works on KUR-2 of high flux reactor (thermal neutron peaking type, 30 MW) have been finished. For the fundamental core design study of the new type reactor, and for general reactor physics studies, a multi-purpose critical assembly is also in plan. The major activities to attain higher intense pulsed neutrons in Japan have been carried out through two categories of pulsed neutron sources; one is thermal pulsed reactor, and another is electron linear accelerator. This work is extended to develop fast repetitive pulsed reactor with electron LINAC as advanced neutron source. An intermediate stage, dynamic booster, proposed to serve a large variety of laboratory programs, will be developed in a high-intensity electron LINAC with Na-cooled fission multiplication assembly and rotating reflector to produce neutron bursts of 10^{15} n/cm^2 · sec in less than 10 μsec. 12 references. (auth)

54193 (A/CONF.49/P–823) STUDIES ON RADIATION EFFECTS AT JAERI. Ishihara, Takehiko; Taketani, Kiyoaki; Yatsurugi, Tatsuo; Watanabe, Katsutoshi; (and others) (Japan Atomic Energy Research Inst., Tokyo). May 1971. 19p. (CONF-710901–345). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The studies on radiation effects of reactor fuels and structural materials have been conducted by mainly utilizing the reactors JRR-2, JRR-3, and JPDR in irradiation and hot laboratories at either Tokai or Oarai site in post-irradiation examinations. Several recent research projects by JAERI for fuel element materials and also the program in JMTR are introduced. The fundamental joint research for structural materials or pressure vessel steel by both University of Tokyo and JAERI is shown. The irradiation test for fuels was conducted by using the Experimental Fuel Test Loop-2 installed in JRR-2, Fission Gas Release Loop in JRR-3, and others. Concerning the reactor materials, Magnox alloys, graphite and others were studied, and more emphasis is placed on stainless steel either for cladding of FBR fuel or for reactor pressure vessels. During the fuel development program for the JPDR-II Project (to double the JPDR's power), several test fuel assemblies were irradiated in JPDR. High-power irradiation tests of four fuel assemblies were successfully conducted at HBWR in Norway. JMTR, Japan's first full-scale material testing reactor, became critical in 1968 and has been continuously operated since 1970. It will be the prime irradiation reactor for future activities. As for the fundamental research for pressure vessel steels, the role of alloying elements in irradiation effects of iron alloys have been investigated since 1966. The materials used were zone melted Fe, pure Fe, Fe–Ni, Fe–Al and Fe–Cr. They were irradiated at JRR-2 and BR-2 in Belgium by 1 ~ 3 × 10^{19} nvt. The relation between irradiation hardening and micro-structures was discussed. The role of solute N_2 (or C) was very important and the role of alloying elements in irradiation effect was interpreted by the interaction between alloying elements and solute N_2 (or C) atoms. 23 references. (auth)

54194 (AE–427) STUDIES OF FINE STRUCTURE IN THE FLUX DISTRIBUTION DUE TO THE HETEROGENEITY IN SOME FRO CORES. Andersson, T. L.; Haeggblom, H. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Jun 1971. 30p. Dep. NTIS (U. S. Sales Only).

The core of the fast critical assembly FRO is built up of a large number of small parallelepipedic pieces of various materials. Due to the core heterogeneity there is a fine structure in the spatial neutron flux distribution. This heterogeneity effect was studied by foil activation techniques in four FRO cores — three uranium cores and one plutonium core. The main interest was devoted to the fine structure in the rate distribution of the important reactions ^{235}U(n,f), ^{238}U(n,f), ^{238}U(n,γ) and ^{239}Pu(n,f). Comparison is made with calculations based on the slab-geometry program FLIS. It is concluded that a reasonably good agreement between the calculated and measured fine structure variations is obtained for the uranium reactions in the uranium cores, whereas for the plutonium core large discrepancies occur. (auth)

54195 (ANCR–1019) PBF TRAINING AND QUALIFICATION PROGRAM. (Aerojet Nuclear Co., Idaho Falls, Idaho). Jul 1971. Contract AT(10-1)-1375. 50p. Dep. NTIS.

Specific training responsibility and organizational relationships are discussed. Training and qualification outline, individual qualification prerequisites and requirements, and individual training and qualification records requirements are given. (6 references) (auth)

54196 (ANL–7757) EBR-II INSTRUMENTED-SUBASSEMBLY SYSTEM: TESTS 1 AND 2. Smaardyk, A.; Dickman, R. J.; Folkrod, J. R.; Forster, G. A.; Knox, A. E.; Poloncsik, J.; Thompson, W. M.; Walker, D. E. (Argonne National Lab., Ill.). Jul 1971. Contract W-31-109-eng-38. 143p. Dep. NTIS.

An instrumented-subassembly system for measuring operating parameters of specimen fuels, instruments, and related components in the core of EBR-II has been developed, fabricated, and operated successfully in the reactor. The fueled subassembly, which contained 23 instruments for measuring six different parameters, was irradiated for 140 days (3856 MWd) in the fifth row of the core, where it replaced a control rod. It was cooled by 700 to 900°F flowing sodium and exposed to a total flux of ~1.9 × 10^{15} n/cm^2-sec at a reactor power of 50 MW(t). The complete system consists of the subassembly, which is similar to a standard EBR-II assembly; an extension tube with an internal coupling; a terminal box through which electrical leads and tubes from the sensors are connected to readout equipment; a drive system for raising and lowering the subassembly during fuel handling; and appropriate data-recording equipment. Before the irradiation of the fueled subassembly, the operational integrity of the system was verified by tests with a nonfueled subassembly while the reactor was subcritical. (10 references) (auth)

54197 (ANL-EBR-19) PROSPECTUS: ROUTINE OPERATION OF EBR-II AT 62.5 MWt. Cushman, R. A.; Loewenstein, W. B.; Smith, R. R.; Walter, C. M. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Jul 1970. Contract W-31-109-eng-38. 85p. Dep. NTIS.

The effect of routine operation of the EBR-II at 62.5 MW(t) has been evaluated. The most important areas reviewed were: capability of existing heat-removal systems to accommodate the power increase; effects of the increase on existing irradiation experiments; and effects, if any, of the increase on nuclear safety. Temperatures of fuel, cladding, coolant, and blanket will be within the guidelines of the original safety documents. Experimental subassemblies, if necessary, can be accommodated by relocation or reconstitution. The performance of driver-fuel and blanket elements will be satisfactory at 62.5 MW(t), as indicated by irradiations and fuel-element modeling studies. The cladding strain at 62.5 MW(t) will be only slightly higher than at 50 MW(t). Rod-drop and power-coefficient measurements provide information on the safety and stability of the reactor. For example, the results indicate that the feedback can be interpolated with reasonable accuracy from data obtained at power levels below 62.5 MW(t). Experience shows that operation with some defective driver-fuel elements can be tolerated for at least a short time. (13 references) (auth)

54198 (ANL-EBR-26) COOLTEMP: COMPUTER CODE FOR CALCULATING COOLANT TEMPERATURES IN EBR-II SUBASSEMBLIES. Wallin, W. R.; Blomberg, P. E.; Koenig, J. F. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). May 1971. Contract W-31-109-eng-38. 57p. Dep. NTIS.

COOLTEMP is a FORTRAN IV computer code that has been developed for use on the IBM 360/75 computer to calculate flow rate, power, and coolant temperature of each subassembly in rows 1–7 of EBR-II. The temperatures calculated are average values at three points above the core. The code is used to predict temperatures for 19 subassembly locations where outlet temperatures are measured by thermocouples. Signals from these thermocouples are used to initiate alarm and, in a few cases, shutdown circuits. Changes in reactor loading resulting from installation of experiments in the reactor cause considerable variation in the temperatures measured. Power in each subassembly, as calculated by COOLTEMP, agrees within a few percent of the power calculated by other codes, except for a few cases where the difference is a maximum of 10%. Flow is believed to be calculated to an accuracy of better than 10%, although comparison with flow measurements in an instrumented subassembly indicated a 12% difference. Subassembly outlet temperature, as measured by the thermocouple, is predicted within about 13°F for the central core position (i.e., a maximum error of about 10% in the 135°F temperature rise in the subassembly). Although power and flow in experimental-irradiation subassemblies may be as much as 90% less than in a normal driver subassembly, the effects of loading changes are represented fairly well. (auth)

54199 (ANL/EBR-28) COLLECTION AND EVALUATION OF KINETICS DATA FROM EBR-II RUN 46A. EBR-II Project. Larson, H. A.; Engen, I. A. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Jan 1971. Contract W-31-109-eng-38. 35p. Dep. NTIS.

Information from rod-drop experiments for run 46A of the EBR-II reactor is analyzed. Experiments were performed at several power levels during the start-of-run approach to 62.5 MW(t) and during the end-of-run reduction in power. By using an XDS Sigma-5 computer system, rod-drop data were collected on line and numerically reduced by an inverse-kinetics procedure to produce drop-rod calibration information, time-dependent reactivity feedback, and frequency-dependent reactivity feedback. After the accuracy of the calculations performed with the XDS Sigma-5 computer system was verified, data and calculations were graphically summarized and comparisons were made with results of run 38A, the previous 62.5 MW(t) run. At the end of run 46A, data were recorded with both compensated and uncompensated ion chambers, thus allowing a comparison of information from the two types of chambers. (9 references) (auth)

54200 (ANL/EBR-36) EBR-II NOISE-SIGNATURE ANALYSIS DURING THE FIRST HALF OF FISCAL YEAR 1971. EBR-II Project. Price, C. C.; Karvinen, J. R. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Feb 1971. Contract W-31-109-eng-38. 58p. Dep. NTIS.

The noise-signature analysis done to date (Feburary 1971) on EBR-II and its auxiliary systems is presented. This effort began with a search for the source of the "10-Hz" noise present in the ion-chamber signals. The search provided a signature of primary-sodium pump No. 1 which could be compared with the signature after an apparent binding of the pump. The comparison indicated more-eccentric rotation of the pump after the apparent binding. The cause was apparently failure of the lower labyrinth seal. On November 4, 1970, an unusual noise was discovered emanating from the intermediate heat exchanger (IHX). A signature obtained on the secondary-sodium outlet pipe of the IHX on August 21, 1970, had not shown any unusual noise present. Further signature-analysis work, described with preliminary results, helped identify the cause of the noise. (4 references) (auth)

54201 (ANL/EBR-37) OPERATION OF EBR-II AS AN IRRADIATION FACILITY AT 62.5 MWt: AN EVALUATION OF PLANT AND REACTOR DATA FROM RUN 46A. EBR-II Project. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Feb 1971. 42p. Dep. NTIS.

The initial operation of EBR-II at 62.5 MW(t) occurred during run 38A in September 1969, with a core containing no fueled experimental subassemblies. Run 38A indicated that the reactor and plant were capable of sustained operation at 62.5 MW(t). After interim operation at 50 MW(t), during which minor adjustments were made to the plant and experimenters were informed of the plan to operate continually at 62.5 MW(t), run 46A was scheduled as the first to contain fueled experimental subassemblies and operate routinely at the higher power level. Experimental subassemblies were modified and relocated as required to match the higher-power conditions, and run 46A was begun. The reactor and plant were monitored during the run, and several special tests were carried out. As a result of the tests, the recommendation is made to continue operation of EBR-II at 62.5 MW(t). (7 references) (auth)

54202 (HEDL-TME-71-18) FEASIBILITY OF LITHIUM ADDITION AS AN ALTERNATE SHUTDOWN METHOD FOR THE FAST TEST REACTOR. Schively, D. P. (Hanford Engineering Development Lab., Richland, Wash.). Feb 1971. Contract AT-(45-1)-2170. 53p. Dep. NTIS.

A soluble liquid metal poison system in conjunction with a mechanical system has the advantage of providing diversification and would thus preclude common-mode faults associated with two mechanical shutdown systems which are similar. The potential use of lithium as a neutron absorber for FTR shutdown was suggested by J. Herb early in 1968. Other investigators since have explored the large variety of available possibilities and have concluded that molten lithium is the only logical choice of liquid poison for use in a sodium system. This choice was accepted after a review of these and other prior investigations. An examination of lithium as a potential liquid poison for usage in alternate shutdown systems for the FTR is presented. The advantages of lithium are: high neutron absorption cross-section, miscibility with sodium, low melting point (~180°C) and high boiling point (1317°C), and high specific heat. Four shutdown methods utilizing lithium were considered: addition of lithium to the primary coolant, a closed loop, and an empty thimble; and a lithium-antimony fuse. The relative worth of the first three of these methods is presented. Reactivity transients were not calculated. 17 references. (auth)

54203 (HEDL-TME-71-30) SUMMARY OF COMPUTER CODES USED FOR FFTF CONTAINMENT AND SITING STUDIES. (Hanford Engineering Development Lab., Richland, Wash.). Feb 1971. Contract AT(45-1)-2170. 60p. Dep. NTIS.

Containment and siting studies for the Fast Flux Test Facilities were conducted to assure adequate margins for public protection against unforeseen events. These studies consisted of analyses of postulated events of an extreme nature beyond any realistic probability for occurrence. Consequences were then investigated analytically to assess the design margins against such unlikely events. Because of the complex nature of these analytical models, it was necessary to use computer codes for these evaluations. The scope of these codes covers the initiation of a hypothetical accident, its immediate consequences in terms of energy, pressure and temperature effects and long term consequences involving the potential for leakage of radioisotopes from containment to the environs and the potential dose at the site boundary. Because the codes utilized in these assessments are in various stages of documentation, a summary description of each is presented. (auth)

54204 (HEDL-TME-71-34) ASSESSMENT OF MAGNITUDE AND UNCERTAINTIES OF HYPOTHETICAL ACCIDENTS FOR FFTF. Simpson, D. E.; Walter, A. E.; Padilla, A. Jr. (Hanford Engineering Development Lab., Richland, Wash.). 27 Mar 1971. Contract AT(45-1)-2170. 144p. Dep. NTIS.

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The performance of mechanistic analyses of a wide variety of hypothetical accident-initiating events and postulated propagating phenomena has been undertaken to determine the sensitivity of calculated results to assumptions and uncertainties in input data. An objective of these analyses was to establish whether the uncertainties and assumptions were bordering on a threshold such that the calculated energy release was highly sensitive to any of the parameters involved. Thus, many of the calculations represent assumptions made solely for the purpose of exploring sensitivities and are not to be considered as having significant realism attached. In the overpower cases, the energy in molten fuel ranges up to about 1400 MW-sec for an extreme ramp reactivity input of 5$/sec. For purposes of providing a test of containment, a work energy of 150 MW-sec was arbitrarily selected, corresponding to 580 MW-sec in molten fuel. This event is taken to be characteristic of a class of overpower accidents in the low hundreds of MW-sec range. In the loss-of-cooling cases, no nuclear core disassembly is calculated to occur, and the energy in molten fuel in the seconds after the core becomes subcritical due to voiding is of the order of 100 MW-sec. The corresponding work energy is very small. The case of passage of an optimum geometry sodium bubble, which has been shown experimentally to be impossible in the initial assumption but is analyzed on an otherwise mechanistic basis, leads to a calculated energy in molten fuel of up to about 1120 MW-sec and a corresponding work energy of 280 MW-sec. (33 references) (auth)

54205 (HEDL-TME-71-35) REVIEW OF TORNADO CONSIDERATIONS FOR FFTF. Simpson, D. E. (Hanford Engineering Development Lab., Richland, Wash.). Jan 1971. Contract AT(45-1)-2170. 32p. Dep. NTIS.

W. L. Dotson of HEDL reviews the likelihood and potential severity of tornadoes in the Hanford region. A more detailed study of tornado occurrences in the Northwest is presented by T. Fujita for Jersey Nuclear Corporation. Dotson's and Fujita's work shows that tornadoes to which the Hanford region might be subject are of much lower severity than the 300 mph tornadoes commonly considered in reactor safety evaluation for the middle-Western and Eastern U. S. Also, the indicated probability of being struck by a tornado at any point is approximately 2 or 3×10^{-6} per year, based on both Dotson's and Fujita's information. Analysis of potential wind forces, pressure transients, and missiles from tornadoes is presented. (auth)

54206 (HEDL-TME-71-50) MECHANICAL CONSEQUENCES OF HYPOTHETICAL CORE DISRUPTIVE ACCIDENTS. Stepnewski, D. D.; Fox, G. L.; Peak, R. D.; Merckx, K. R. (Hanford Engineering Development Lab., Richland, Wash.). 19 Apr 1971. Contract AT(45-1)-2170. 125p. Dep. NTIS.

A description is presented of the potential consequences of hypothetical core disruptive accidents on the primary coolant boundary. The effects of the postulated accidents on containment structures are analyzed in the event of energy releases beyond the primary coolant boundary. The objective of this treatment of the accident mechanisms is to demonstrate the capability of FFTF design features, both inherent in the primary boundary and in containment structures to effectively isolate limiting severe accidents from the environs of the facility. The basic input upon which this mechanical assessment is made is taken from hypothetical accident energy release information developed for the FFTF reactor. Detailed analyses of the reactor vessel and primary boundary have been performed in order to identify accident induced loads. The systems are designed to withstand these loads without loss of required capability. The basic functional requirement is that the reactor coolant system retain the capability to cool the core under any accident conditions, including those hypothetical conditions involving disassembly and melting of the core. (auth)

54207 (HEDL-TME-71-81) CALCULATION OF THE ISOTHERMAL DOPPLER COEFFICIENT FOR THE SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR (SEFOR). O'Dell, L. D. (Hanford Engineering Development Lab., Richland, Wash.). May 1971. Contract AT(45-1)-2170. 29p. Dep. NTIS.

A series of one-dimensional calculations are described for the Southwest Experimental Fast Oxide Reactor, SEFOR. These calculations were performed in order to determine the model requirements for calculating the SEFOR Doppler coefficient. Selected whole core sodium worths were also calculated. (6 references) (auth)

54208 (HEDL-TME-71-89) DOPPLER COEFFICIENT MODELS AND CALCULATIONS FOR THE FAST TEST REACTOR (FTR). O'Dell, L. D. (Hanford Engineering Development Lab., Richland, Wash.). Jun 1971. Contract AT(45-1)-2170. 28p. Dep. NTIS.

A series of Doppler coefficient calculations are described for the Fast Test Reactor (FTR). These calculations were performed to determine model requirements for calculating the FTR Doppler coefficient and to ascertain how the FTR Doppler coefficient varies with core burnup and temperature. The effect of changes in core volume and reflector material on the Doppler coefficient are also presented. (4 references) (auth)

54209 (NP-18981) VARIATION WITH SPACE AND TIME OF THE NEUTRON ENERGY DISTRIBUTION IN PULSED BeO ASSEMBLIES. Ritchie, A. I. M. (Wollongong Univ. Coll. (Australia)). Apr 1970. 182p. Dep. NTIS (U. S. Sales Only).

Thesis.

Time dependent spatial distributions were measured in BeO assemblies covering the buckling range 0.0083 to 0.0399 cm^{-2} referred to a density of 2.96 gm cm^{-3}. The extrapolated length did not change with time if $\lambda < \lambda^*$; changed by $(0.5 \pm 0.25)\%/10^3$ μs in the time range 1.4 to 2.9 ms at buckling of 0.0292 cm^{-2}; and by $(2.0 \pm 0.5)\%/10^3$ μs over a similar range of 0.0399 cm^{-2} $(\lambda < \lambda_K)$. The decay constant of the next higher spatial mode (211) did not lie on the $\lambda(B^2)$ curve of the fundamental. In the region $\lambda^* < \lambda < \lambda_K$ decay constants were generally higher than the fundamental. For $\lambda > \lambda_K$ the constants tended to lie below the $\lambda(B^2)$ curve. Marginal space dependence was found for the effective decay constant of the lowest mode of decay for $\lambda > \lambda_K$. Calculations were made, based on a multigroup diffusion code which approximated leakage by a DB^2 term. The term dependent energy spectra corresponding to a number of Fourier modes were used to give the energy spectrum. Spatial distributions corresponding to a 1/v reaction rate were compared with experimental results. The cross section set ranged from 1.125 to 9.36×10^{-6} eV with 18 groups below the 23 above Bragg cut-off. Other comparisons with theory indicated good agreement with decrease of extrapolation distance with buckling seen in the assemblies with $\lambda < \lambda^*$; an overestimation of the amplitude of asymmetric modes; differing dependence of decay constant with both time and position; and an extrapolated length of a factor of 4 too small to correlate with experimental results. 70 references. (Australia)

54210 (ORNL-TM-3559) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT: APRIL, MAY, AND JUNE OF 1971. Hurt III, S. S.; Tabor, W. H. (Oak Ridge National Lab., Tenn.). 27 Aug 1971. 44p. Dep. NTIS.

An average power level of 29.8 MW was maintained at the ORR for 86.9% of the time during April, May, and June of 1971. An unusually large number of shutdowns (21) were recorded; however, ten of these followed special test runs during the end-of-cycle 99 shutdown. Only three of the shutdowns were unscheduled. Fuel usage continued to be quite satisfactory, with the average burnup (decrease of ^{235}U) of 15 fuel elements at 52.9%. Sixty-six Nuclear Engineering Test Reactor fuel elements were received from Wright-Patterson Air Force Base, completing a total shipment of 90 elements. These elements are being held for future modification for use in the ORR. Additional monitoring circuits for the No. 3 dc unit were installed to complete the work described in instrumentation and controls design change memo No. ORR-96. Procedures and checks (tests) were revised to include the new monitoring circuits. New fission chamber assemblies (snakes) of the HFIR type were installed for the counting-rate channels. Monitoring circuits for the battery charger associated with the diesel starter battery were installed as specified in mechanical change memo No. ORR-12. An inspection of the exterior of the poolside facility revealed only surface scratches and very shallow pits. (auth)

54211 (ORNL-TM-3560) BULK SHIELDING FACILITY QUARTERLY REPORT: APRIL, MAY, AND JUNE OF 1971. Tabor, W. H.; Hurt III, S. S.; Lance, E. D. (Oak Ridge National Lab., Tenn.). 1 Sep 1971. 31p. Dep. NTIS.

The BSR operated at an average power level of 1,759 kW for 20.2% of the time during April, May, and June of 1971. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. There were no unscheduled shutdowns during the quarter. Changes as authorized by reactor instrument and controls design change memo No. BSR-2Mw-30 were completed. The changes on shim-rod assemblies Nos. 1, 2, 3, 5, and 6 were completed during the first quarter of 1971. The changes on shim-rod assembly No. 4 were completed this quarter as follows: removal of the guide tube 16-in. extension and replacement of the high-voltage, unplated magnet with the low-voltage, high-current, nickel-plated magnet. The No. 5 control-rod-drive unit nickel-plated magnet was inspected for corrosion. The magnet, which had been in service since October 27, 1970, showed no evidence of corrosion. The BSR and PCA were used in conducting the annual experiments for students of the Nuclear Engineering Departments of the University of Tennessee, the University of Kentucky, and Mississippi State University. (auth)

54212 (RFP–1489) MIXTURES OF PLUTONIUM AND ENRICHED URANIUM IN SLAB GEOMETRY. Schuske, C. Lee; Coonfield, Donald C. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 10 Aug 1971. Contract AT(29-1)-1106. 8p. Dep. NTIS.

The multiplication factors have been calculated for several systems composed of alternate slab regions of plutonium and enriched uranium. The slab systems are unreflected and consist of either pure metal or metal-water solutions at a hydrogen-to-fissile element atomic ratio of 50. The calculations were done with the Computer Code DTF in the S_4 approximation. Slab geometry is used as a simplifying model to simulate possible complex array-storage combinations of plutonium and enriched uranium. The analysis indicates that certain combinations of pure metal are much more reactive than others. For the pure metal case with plutonium surrounded by uranium, the reactivity is 12 percent greater than when the plutonium surrounds the uranium. It is concluded that criticality safety limits for metal storage should include safety margins to account for the effect. For similar hydrogenous systems of plutonium and enriched uranium, only a slight effect was noted. (auth)

54213 (SC-M–710227) OPERATING MANUAL FOR SANDIA PULSED REACTOR II. Snyder, John A. (Sandia Labs., Albuquerque, N. Mex.). Jun 1971. 87p. Dep. NTIS.

The operating manual for the Sandia Pulsed Reactor 2 includes: facility description; reactor description; SPR 2 control system; SPR 2 interlock system; procedures for operations and experiments; facility supervision; and fuel-handling procedures. (D.C.C.)

54214 (TID–25779) COMPARISON OF METHODS FOR HETEROGENEITY ANALYSIS. Quarterly Technical Progress Report, June–September 1970. Page, E. M. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 24p. Dep. NTIS.

Calculations of heterogeneity effects in Assembly 6 of ZPR-6 are presented. Effects on sodium void analysis are studied. (15 references) (D.C.C.)

54215 NEUTRON SPECTRA AND KINETIC PROPERTIES IN FAST SUBCRITICAL ASSEMBLIES CONTAINING ^{235}U, ^{238}U, AND CARBON. d'Oultremont, P.; Young, J. C.; Neill, J. M.; Preskitt, C. A. (Gulf Radiation Tech., San Diego, Calif.). Contract AT(04-3)-167. Nucl. Sci. Eng.; 45: No. 2, 141–55 (Aug 1971).

A subcritical time-of-flight spectrum facility (STSF) was used to study the neutron spectra and kinetics of two fast assemblies designated STSF-2 and STSF-2A. Neutron spectra were measured by the time-of-flight method between 5 MeV and 500 eV in the core and the reflector of the STSF-2 which is essentially the same as the ZPR-3 Assembly 17. The STSF-2 core was loaded with plate type elements and the neutron spectrum was determined at the surface of a graphite plate, an enriched uranium plate, and a depleted uranium plate. Detailed transport calculations were performed with ENDF/B version 1 cross sections and compared to the experimental data which had been reduced by an original method. Finally, kinetic measurements were performed on assembly STSF-2A which confirm the validity of the time-dependent calculations involved in the time-of-flight data analysis. 21 references. (auth)

54216 NUCLEAR REACTORS. Everson, Ivor; George, Maurice William (to United Kingdom Atomic Energy Authority). U. S. Patent 3,580,803. 25 May 1971. Priority date 21 Sep 1966, Great Britain.

A nuclear reactor is described comprising a plurality of nuclear fuel elements grouped to form a core assembly within a reactor vessel. Means are provided to transfer the core assembly between its reactor operating station and a second non-operating station within the vessel. (auth)

54217 DUAL SPECTRUM CONCEPT FOR LMFBR FUEL ASSAY. Kelber, Charles (Argonne National Lab., Ill.). Nucl. Technol.; 10: No. 1, 85-90(Jan 1971).

One of the methods considered for fuel assay in a nuclear safeguards program is analysis of reactivity response. For uranium-plutonium LMFBR fuels, such an assay is complicated by the similar response of the various fissile isotopes and the relatively large fast fission contribution from the fertile isotopes. The proposal is explored to separate the responses, thereby promoting more accurate analysis, through design of an assay reactor which would be critical in two distinct modes having different spectra (hard and soft). The constraint is that the change in spectrum be obtained with little mechanical change in the system so as to avoid excessive reactivity renormalization. The solution examined is a concept of a dilute fast spectrum fast reactor (zero-power) which is also critical when flooded with borated water. The response matrix is computed and the errors analyzed; problems in securing greater accuracy arise from the need to attain very low powers to measure spontaneous fission sources in the presence of fission product gammas, and the need for a better low energy neutron filter than cadmium. (9 references) (auth)

54218 OPERATING EXPERIENCE AT SEFOR. Steele, Myrna L. (Atomic Energy Commission, Oak Ridge, Tenn.). Reactor Technol.; 14: No. 3, 237-40(Fall 1971).

The highlights of operation of SEFOR from August 1970 to January 1971 are summarized. Maintenance and repair activities for this period are reported. 4 references. (auth)

54219 EBR-II: AN EXPERIMENTAL LMFBR POWER PLANT. Koch, Leonard J. (Argonne National Lab., Ill.). Reactor Technol.; 14: No. 3, 286-311(Fall 1971).

Experimental Breeder Reactor II (EBR-II) is an experimental liquid-metal-cooled fast breeder reactor (LMFBR) power-generating station designed to operate on a utility-system network. It is the only operational pool-type LMFBR, and through 1970 it had produced more than 40,000 MWd(t) of power and had generated over 250 million kWh of electricity. The primary mission of the EBR-II has been shifted to an experimental irradiation facility for potential LMFBR fuels and structural materials. The experimental irradiation program has had a significant effect on operating schedules and on the amount and character of fuel-handling operations. Nevertheless, power operation of the EBR-II normally includes electric-power generation and relevant experience as an experimental power station. Many difficulties arose during preoperational testing and the early operating phases of the EBR-II. These were corrected, and since 1967 the reactor and power system have operated very well, simultaneously increasing the number and variety of experimental irradiations conducted in the reactor. The EBR-II has demonstrated the technical feasibility of the pool-type LMFBR concept and provides a technological basis for the major commitments made to this concept. 7 references. (auth)

Rocket and Space Reactors

Refer also to abstract 53920.

54220 (N–71-15163) NUCLEAR ROCKET SHIELDING METHODS, MODIFICATION, UPDATING, AND INPUT DATA PREPARATION. VOLUME 2. COMPILATION OF NEUTRON AND PHOTON CROSS SECTION DATA. Final Progress Report. Soltesz, R. G.; Kaiser, R. S.; Disney, R. K. (Westinghouse Electric Corp., Large, Pa. Astronuclear Lab.). Aug 1970. Contract NAS8-24919. 130p. (NASA-CR–102965; WANL–PR(LL)–34(Vol.2)). NTIS.

The compilation and preparation of neutron and photon cross section data are described with the material being subdivided into the following categories: (1) neutron cross sections for the ANISN-W DOT-2W discrete ordinates transport codes and their auxiliary codes; (2) photon cross sections for the ANISN-W and DOT-2W discrete ordinates transport codes, KAP-6 point kernel code, and the SCAP single- and albedo-scatter code; (3) preparation of multigroup cross section sets (with upscatter removed, if desired), using a modified version of the ANISN code or the APPROPOS cross section preparation code; and (4) basic, nuclear data for nuclear and radiation analysis of a nuclear system. (auth) (STAR)

54221 (N–71-15164) NUCLEAR ROCKET SHIELDING METHODS, MODIFICATION, UPDATING, AND INPUT DATA PREPARATION. VOLUME 3. CROSS SECTION GENERATION AND DATA PROCESSING TECHNIQUES. Final Progress Report. Soltes, R. G.; Disney, R. K.; Zeigler, S. L. (Westinghouse Electric Corp., Large, Pa. Astronuclear Lab.). Aug 1970. Contract NAS8-24919. 419p. (NASA-CR–102966; WANL–PR(LL)–34(Vol.3)). NTIS.

A description of the cross section generation and data processing techniques for analyzing nuclear reactor systems is given. These techniques include: (1) the GAMLEG-W code for generating multigroup photon cross sections for use in discrete ordinate and Monte Carlo transport codes; (2) the APPROPOS code for preparing multigroup, simultaneous, neutron-photon cross section data and neutron reaction cross section data for radiation transport codes; (3) the NAGS code for processing the output fluxes from one- and two-dimensional discrete ordinate transport codes to provide neutron and gamma ray distributed source data as well as nuclear energy deposition; and (4) the SATURN code for processing master library cross section data including optional transverse leakage corrections, adjoint reversals, and mixture operations. Detailed user information is supplied for each code. This information includes problem setup, running time, required input data, and tape and core storage requirements. A sample problem card input and printout as well as a

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description of printed, punched and tape output are included for each code. (auth) (STAR)

54222 (N–71-15165) NUCLEAR ROCKET SHIELDING METHODS, MODIFICATION, UPDATING, AND INPUT DATA PREPARATION. VOLUME 4. ONE-DIMENSIONAL, DISCRETE ORDINATES TRANSPORT TECHNIQUE. Final Progress Report. Soltesz, R. G.; Disney, R. K. (Westinghouse Electric Corp., Large, Pa. Astronuclear Lab.). Aug 1970. Contract NAS8-24919. 103p. (NASA-CR-102967; WANL-PR(LL)-34(Vol.4)). NTIS.

The proposed version of the ANISN computer code for solving the one-dimensional, energy dependent, linear Boltzmann transport equation with general anisotropic scattering is described. The major improvements of the ANISN-W code over the ANISN code are: (1) the inclusion of automated tape linkage of input and output data, and (2) the capability to input a distributed or shell source from cards and/or from tape. Detailed user information including problem setup, running time, boundary conditions, quadrature data, and mesh spacing requirements is described. In addition, requirements for cross section weighting, search calculations, activities, and stacked problems are given. Typical problem setup information is supplied as well as a description of the printed output. A sample problem card input and printout are included. (auth) (STAR)

54223 (N–71-15166) NUCLEAR ROCKET SHIELDING METHODS, MODIFICATION, UPDATING, AND INPUT DATA PREPARATION. VOLUME 5. TWO-DIMENSIONAL, DISCRETE ORDINATES TRANSPORT TECHNIQUE. Final Progress Report. Soltesz, R. G.; Disney, R. K.; Jedruch, J.; Zeigler, S. L. (Westinghouse Electric Corp., Large, Pa. Astronuclear Lab.). Aug 1970. Contract NAS8-24919. 426p. (NASA-CR-102968; WANL-PR(LL)-34(Vol.5)). NTIS.

The proposed version of the DOT computer code for solving the two-dimensional, energy dependent, linear Boltzmann transport equation with general anisotropic scattering, and the MAP computer code for solving for the annular, spatial, and energy dependent flux external to a nuclear system are described. The major improvements of the DOT-2W code over the DOT code are the inclusion of acceleration techniques on the group flux solution, improved convergence logic, asymmetric quadrature capability, and improved tape operations. Detailed user information involving problem setup, running time, quadrature data, and mesh spacing requirements is described for both codes. In addition, requirements for eigenvalue, fixed volume distributed source, boundary source, and search calculations are given for the DOT-2 code. Typical problem setup information is supplied for both codes as well as a description of the printed output. A sample problem card input and printout are included for each code. The appendix describes the DOQ and ADOQ quadrature coefficient calculation codes. (auth) (STAR)

54224 (N–71-15167) NUCLEAR ROCKET SHIELDING METHODS, MODIFICATION, UPDATING, AND INPUT DATA PREPARATION. VOLUME 6. POINT KERNEL TECHNIQUES. Final Progress Report. Disney, R. K. (Westinghouse Electric Corp., Large, Pa. Astronuclear Lab.). Aug 1970. Contract NAS8-24919. 286p. (NASA-CR-102969; WANL-PR(LL)-34(Vol.6)). NTIS.

The KAP 6 computer code for solving energy dependent radiation transport external to a radiation source is described. KAP 6 is a revised version of the KAP 5 code and is written in standard USASI FORTRAN 4. Revisions include the data input interface with the GAMLEG-W and NAGS code, as well as options to preferentially exclude multiple scatter buildup approximations in certain zones. The KAP 6 (Point Kernel Attenuation Program) code employs the point kernel method to calculate neutron and gamma ray radiation levels at detector points located within or outside a complex geometry describable by a combination of quadratic surfaces. The attenuation function, or kernel, for gamma rays employs exponential attenuation along with a buildup factor to account for multiple scales. Three optional fast neutron attenuation functions are included: (1) a modified Albert–Welton function for calculating fast neutron dose rate using removal cross sections; (2) a bivariant polynomial expression for computing neutron spectra using infinite media moment data; and (3) a monovariant polynomial expression for computing neutron spectra using infinite media moments data. The code also handles either cylindrical, spherical, disc, line, or point sources. A variety of options are available for describing neutron or gamma ray source distributions in complex geometries. (auth) (STAR)

54225 (N–71-22511) SNAP 8 REFRACTORY BOILER DEVELOPMENT PROGRAM: MERCURY THERMAL SHOCK TESTING OF 2 $1/2$-INCH-DIAMETER BIMETALLIC JOINTS FOR SNAP 8 APPLICATIONS. Topical Report No. 4. Thompson, S. R. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). [1970]. Contract NAS3-10610. 45p. (NASA-CR-72829; GESP-587). NTIS.

Coextruded and brazed tubular transition joints, between 2.5-inch-outside diameter tantalum and Type 316 stainless steel, were evaluated for usage in the SNAP-8 Mercury Power Conversion System. Representative joints were exposed to repeated thermal shocks by flowing 300°F mercury through the joints which were initially heated to 1300°F. Failure of the coextruded specimen occurred after 55 thermal shocks; no brazed joint failure was noted after testing to 100 and 155 cycles (two brazed samples). Posttest destructive and nondestructive examination of the sample assemblies indicated that the braze method produced assemblies which were essentially unaffected by the shock testing. The results of the above testing, and other severe thermal shock tests of this type of joint, show that the brazing method for effecting transitions between tantalum and stainless steel will produce a reliable joint for SNAP-8 applications. (auth) (STAR)

54226 (N–71-22512) SNAP 8 REFRACTORY BOILER DEVELOPMENT PROGRAM: SHELL SIDE HYDRAULIC CHARACTERISTICS OF A FULL SCALE SNAP 8 MULTIPLE TUBE MODEL BOILER. Topical Report No. 5. Hsia, E. S.; Fuller, R. A. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). [1970]. Contract NAS3-10610. 95p. (NASA-CR-72830; GESP-589). NTIS.

Shell side hydraulic characteristics of a full-scale SNAP-8 multiple-tube model boiler were thoroughly investigated over a turbulent Reynolds number range from 18,000 to 38,000. Friction factors for flow parallel to a tube bundle with or without turbulence promoters were determined experimentally. Loss coefficients for tube supporting spacers and exit or inlet manifolds were also measured experimentally. In addition, the effect of the incoming flow condition on these loss coefficients was investigated. With the aid of upstream dye injections, a visual study was made on the shell side flow distribution affected by turbulence promoters and the exit hole-slotted baffle. Results are presented in graphical forms. (auth) (STAR)

54227 (N–71-22618) MISSION PERFORMANCE POTENTIAL OF REGENERATIVELY COOLED GAS CORE NUCLEAR ROCKETS. Fishbach, Laurence H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr 1971. 19p. (NASA-TM-X-2256). NTIS.

The performance of regeneratively cooled gas-core nuclear rockets is compared to that of solid-core nuclear rockets for four missions: a reusable lunar ferry; a slingshot, in which an orbiting rocket boosts payloads to various hyperbolic excess velocities and then returns to orbit; and manned round trips to Mars and to Jupiter. The results indicate that gas-core nuclear rockets may offer a significant capability improvement for performing these missions, requiring only 50 to 75 percent of the initial mass in earth orbit needed by the solid-core rocket. In addition, high specific impulse, even with a corresponding increase in engine weight, seems desirable. (auth) (STAR)

54228 FISSION PRODUCTS IN REACTOR DYNAMICS. Woyski, Jan S. (McDonnell Douglas Astronautics Co., Santa Monica, Calif.). Nucl. Technol.; 10: No. 1, 11-16(Jan 1971).

An evaluation of fission products decay heating is required to protect a nuclear reactor from overheating after shutdown or to make proper use of this available decay heat. It may, therefore, prove convenient and practical to have the fission product decay heating included continuously in the reactor dynamics model like the delayed neutrons, following any changes in the reactor power level. This would be useful particularly in a multiple start-stop operation. In the method presented, a modified Way–Wigner formulation is used to introduce the fission products decay heat in the reactor heat balance equation, following continuously any changes in operating conditions. A reference graph has been prepared showing computed and normalized fission products power decay after different operating times, with the decay curves arranged in time sequence. Their starting points show the fission products power buildup during reactor operation. Following the delayed neutron pattern, several decay groups are used in order to make the equations fit the graph. The number of decay groups and the amount of detail in the reference graph depend on the desired accuracy. In the results shown of an analog simulation study, satisfactory agreement was reached between the analog plot and the reference decay and buildup curves. The method can be applied to any reactor type and nuclear fission process when a desired dynamics model as well as fission product decay data are available. In addition, xenon poisoning equations are shown adapted to the normalized reactor model. (13 references) (auth)

54229 IN-FLIGHT COOLANT MANAGEMENT CONSIDERATIONS FOR THE NERVA REACTOR COOLDOWN. Misra, B.; Altseimer, J. H.; Hart, G. D. (Aerojet Nuclear Systems Corp., Sacramento, Calif.). Nucl. Technol.; 12: No. 3, 298-306(Nov 1971).

Compared with chemical in-space rocket engines, the NERVA nuclear rocket engine presents several unique operational characteristics. This is particularly true in the post-shutdown phase called "pulse cooldown". At this time liquid hydrogen coolant is tank-pressure fed, the tank being pressurized by gaseous hydrogen. At low reactor cooldown power levels the tank ullage gas can be used as the coolant. Thus, there exists the operational option of using either liquid or gaseous hydrogen for coolant; this can be used to eliminate tank venting and also to minimize fluid residual weight in the tank. For a typical four-burn lunar mission it was found that the proper combination of liquid and gaseous coolant fluids gained 27,000 lbm or 18% in payload delivered to lunar orbit, compared to the case when only liquid hydrogen was used for reactor cooldown. In addition, an increased flexibility of flight operations is indicated because tank conditions can be adjusted enroute by choice of the cooldown fluid modes. (auth)

54230 NUCLEAR POWER PLANTS FOR THE USE IN SPACE. Budnick, D. Siemens-Z.; 44: No. 8, 483-8(1970). (In German).

The development of the in-core thermionic reactor (ITR) opens new perspectives. Its central fuel rods contain thermionic energy converters. Electric power in the range from 20 to 200 kW necessary for satellites, space stations, and space probes can be economically produced by these converters. The development status of this reactor type in the FRG is discussed in detail. (INIS)

Process Heat and Desalination Reactors

Refer also to abstracts 53894, 53921, 53922, 54125, and 54162.

54231 (A/CONF.49/P-18) NUCLEAR ENERGY FOR DESALINATION AND AGRO-INDUSTRIAL COMPLEXES IN ISRAEL. Adar, J. (Israel Atomic Energy Commission, Tel Aviv). Apr 1971. 25p. (CONF-710901-68). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In the first part of the review the water resources of Israel and the water consumption are presented. An anticipated gap of 1,000 million cubic meters per year at the end of the century between supply and demand will have to be filled by unconventional sources, mainly seawater desalination. Desalination activities in Israel are reviewed. Desalinated water using present technology being too expensive for agriculture, research and development in view of improved processes are actively being run. Existing prototype units operating or being built in Israel are reviewed, as well as the various processes developed. The large dual-purpose plants studies run are reviewed and the cost of desalted seawater arrived at in each case is stated. The suitability of the power and water grids to large scale dual purpose plants is explained and the various studies presented with their results. A preliminary study made in 1967/68 for a desalting power industrial complex in Israel is reviewed. Eight chemical-metallurgical processes, which together require more than 900 MW(e) at the capacities envisaged were selected for further study. (auth)

54232 (A/CONF.49/P-140) STUDIES FOR THE POTENTIAL USE OF NUCLEAR DESALINATION IN THE UNITED ARAB REPUBLIC. El Guebeily, M. A.; Effat, K. E.; El Fouly, M. F.; (and others) (Atomic Energy Establishment, Cairo (Egypt)). May 1971. 20p. (CONF-710901-80). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The long range water requirements and resources are outlined. Desalination is envisaged as a promising future source. Thus since 1964 in the first nuclear power project (150 MW), a pilot desalination unit of 20,000 m^3/day was included for feasibility studies of the use of desalted water in agriculture. Although the project was not realized, studies concerning economic and technical evaluation of the pilot agricultural scheme continued. Calculations are based on estimated cost of desalted water, engineering requirements of water utilization, distribution system, and on cropping patterns using high cash value, low water consumption crops. This study has shown that for the anticipated cost of desalted water, reasonable returns could be achieved. A study of a prototype single purpose desalination nuclear plant was initiated. In the choice of reactor type and configurations main consideration was given to the need for simple designs, simple materials and cheap construction within the capabilities of developing countries. Study led to a 50 MW(t) natural uranium, heavy water moderated reactor with light water or CO_2 cooling. Reactor power and size of the desalination plant correspond to water needs of the agricultural experiment. The investigations include design studies and research in various reactor disciplines. The choice of concept, plan of studies, supporting research programs and main results are discussed. 13 references. (auth)

54233 (A/CONF.49/P-177) ROVI: DEVELOPMENT FOR INTERMEDIATE CAPACITY DESALTING PLANT DRIVEN BY AN ORGANIC COOLED AND MODERATED REACTOR. Bertoni, C. C.; Di Menza, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)); Biondi, L. (Montecatini Edison, Milan (Italy)); Crispino, E.; (and others) (Agip Nucleare, Milan (Italy)). May 1971. 15p. (CONF-710901-185). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The preliminary design parameters and cost evaluation of a reference plant, driven by a 220 MW(t) reactor, producing through multistage flash units around 110,111 cubic meters/d of fresh water are presented. The necessary actions are being carried out to adapt the reference solution to the requirements of a water needy area in Southern Italy and to obtain the necessary financing for the realization there of a demonstration plant. Starting from the results of the original evaluation, the reference plant and the economic considerations related to its construction and operation are described. (auth)

54234 (A/CONF.49/P-299) PROSPECTS OF A DUAL-PURPOSE NUCLEAR PLANT FOR MEETING WATER AND POWER REQUIREMENTS OF THE GREATER KARACHI AREA. Kamal, Ismat (Pakistan Atomic Energy Commission, Karachi). Jun 1971. 17p. (CONF-710901-373). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The results of studies on the feasibility of nuclear desalination and power generation in the coastal areas of Pakistan with particular reference to the Karachi–Sonmiani area are presented. The rapid economic development of the Karachi area over the past two decades is discussed vis-a-vis the water and power supply situation. Projections of water demand are worked out on the basis of the past rate of growth and future expansion of population. Alternative sources of water supply from surface reservoirs are evaluated. The future power demand is considered in terms of integration with the Northern Grid of West Pakistan. It is concluded that there is adequate justification for a detailed feasibility study of a plant producing 400 to 500 Megawatt electric power and 100 to 150 million gallons of fresh water per day to come into operation by 1980. Cost estimates of dual-purpose nuclear plants using proven reactor concepts are given and compared with conventional plants to meet the expected demand. It is concluded that a nuclear plant would provide the cheapest alternative for meeting the power and water requirements. 13 references. (auth)

54235 (A/CONF.49/P-311) COMBINED NUCLEAR HEAT AND POWER PRODUCTION IN SWEDEN AND RELATED SAFETY PROBLEMS. Bergstroem, Stig O. W. (Aktiebolaget Atomenergi, Studsvik (Sweden)); Almqvist, Per; Groop, Sven (Swedish State Power Board, Stockholm); Grossing, Knut; (and others) May 1971. 12p. (CONF-710901-270). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In 1969 a study was started to evaluate safety problems of nuclear units and relate them to the technical economical characteristics of different alternatives. The first part of this official study considers the environmental effects of combined heat and power plants as a function of city population, distance from population center, and exclusion radius. The nuclear alternative is shown to be environmentally more favorable than the oil fired in normal operation. It is suggested that this superiority is quantified in common units of either health effects or money. This annual saving may be used to define permissible accidental effects. These effects are compared with the calculated effects from different standardized short time activity releases. 11 references. (auth)

54236 (A/CONF.49/P-371) SMALL AND MEDIUM SIZE NUCLEAR POWER STATIONS: OPERATING EXPERIENCES, POSSIBILITIES FOR UTILIZATION WITH SPECIAL REGARD TO FRESH-WATER PRODUCTION AND ECONOMICS. Bohmann, W. (Kraftwerk Union A.G., Erlangen (West Germany)); Bugl, J. (Brown, Boveri/Krupp Reaktorbau G.m.b.H., Mannheim (West Germany)); Drude, B. C.; (and others). Apr 1971. 29p. (CONF-710901-128). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The use of nuclear power stations up to 500 MW(e) for combined power and heat generation is examined. Power supply to large-scale fresh-water production plants deserves particular attention

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in this connection. Also outlined is the technology of the reactor concepts proposed, with the reasons being developed from the available operating experience. Light-water reactors of the conventional types, an integrated pressurized-water concept, considerations on the natural-uranium reactor and the high-temperature gas-cooled reactor are dealt with. Economic problems of this group of nuclear power stations are discussed. First, a comparison of overall generating costs with those of other suitable types of energy including the changes in cost having arisen over the past few years is given. The economically promising capacity range for the use of nuclear power stations is derived from the considerations together with the varying cost structures of the suitable types of power stations and the cost changes due to external influences such as changes in fuel costs, interest on capital, etc. 20 references. (auth)

54237 (A/CONF.49/P–484) FACTORS INFLUENCING THE INTEGRATION OF NUCLEAR POWER AND WATER DESALINATION PLANT. Chambers, S. (Atomic Energy Establishment, Winfrith (England)); Drake, F. A. (Binnie and Partners, London); Masters, E. F. O. (Preece, Cardew and Rider, Brighton, Sussex, Eng.). May 1971. 12p. (CONF-710901–289). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The situation in which different types of desalting plants are applicable is analyzed. The only nuclear dual-purpose plant which is commercially viable incorporates multi-stage flash distillation plant. Optimization of plant combinations is discussed and technical factors such as nuclear safety, relative plant availabilities and reliabilities, water/power ratios with various sources, and brine disposal problems are commented on. 12 references. (auth)

54238 (A/CONF.49/P–529) PROSPECTS AND PLANNING FOR NUCLEAR POWERED AGRO-INDUSTRIAL COMPLEXES IN INDIA. Thomas, K. T.; Sunder Rajan, N. S.; Ramani, M. P. S. (Bhabha Atomic Research Centre, Bombay (India)). May 1971. 32p. (CONF-710901–297). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A summary of a study on the application of the concept of Agro-Industrial Complexes in India based on nuclear energy is presented. One site investigated is the semi arid Kutch–Saurashtra region, where a dual purpose nuclear plant has been studied for production of power and water. The other locale studied is in the Western Gangetic Plains, where a single purpose nuclear power station has been considered. Power is utilized for power intensive industries with special emphasis on power based processes for fertilizer production. Whereas in the Kutch–Saurashtra project the water produced will be used in an attached farm, a part of the power produced in the Gangetic Plain project will be used for massive underground exploitation by energizing tubewells for intensive agriculture. The technical and economic viability of the concept in the two locales is established. The problems that a developing country such as India would have to face in transforming the above concept into physical reality are high-lighted. The need to substantiate certain basic assumptions made by the study, with regard to the availability of the necessary indigenous technical knowhow on the industrial side, the feasibility of multiple cropping, and adoption of modern agricultural practices on the agricultural side, and the scenario contemplated for achieving the above, are presented. The problems of basic infrastructure, limitations of finance and indigenous technical knowhow, regional imbalances, and other socio-political factors that have to be overcome are analyzed. The sequential decision-making steps that need to be taken for successful implementation of the nuclear-powered agro-industrial complexes in India are presented. (auth)

54239 (A/CONF.49/P–552) ALGO-AGRO-INDUSTRIAL COMPLEX. AN AGRO-INDUSTRIAL COMPLEX AT NUCLEAR ENERGY CENTERS WITH ASSOCIATED PRODUCTION OF AUTOTROPHIC MICROORGANISMS. Malek, I.; Bartos, J.; Simmer, J.; Prokes, B. (Ceskoslovenska Akademie Ved, Prague. Inst. of Microbiology). May 1971. 22p. (CONF-710901–240). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The production and technological parameters of cultivation of field crops and autotrophic organisms (AM, particularly algae and blue-green algae) are discussed. It is shown that Am are the most suitable producers of protein under conditions of sufficient electrical energy and insufficient supply of water and availability of agricultural soil. Such conditions will frequently be characteristic of the surroundings of atomic reactors producing electrical energy and desalinated water. A model is presented of an Algo-Agro-Industrial Complex (AAIC), which is balanced in its production and economy and which contains the production of protein bio-mass of Am as a substantial component of its structure. The individual production cycles are developed in some detail with orientative information on material and energy relations. The cultivation of algae in the AAIC will produce 160 tons protein per day on an area of 2,000 hectares, with a consumption of 200,000 tons of water and 4,000 MWh electrical energy. The feasibility of the project is documented by an economic analysis. 10 references. (auth)

54240 (A/CONF.49/P–590) DISTILLATION CYCLE AND THE COMBINATION OF PROCESSES WHICH ARE APPLICABLE TO LARGE-CAPACITY DESALINATION PLANTS. Balligand, P.; Huyghe, J.; Lauro, F.; Vignet, P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jun 1971. 15p. (CONF-710901–401). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The design features of a 25,000 m^3/d fresh water unit, the multiplication of which can provide several hundreds of thousands m^3/d of desalted water, in a dual-purpose reactor are described. The units can operate independently to give the maximum flexibility and reliability. Two classical processes are combined multiple-effect with L. T. V. evaporators in the high temperature part of the unit, and multi-flash in the cold part. The multiple-effect process in the high temperature part allows heating sea water up to 135°C without important scaling risk; the multi-flash process in the cold part of the unit allows the use of concrete flash chambers with long tube condensers. The two parts of the unit are connected through a condenser heater, in which the vapor coming from the last L. T. V. effect condenses and heats the brine to be partly recycled into the multi-flash part of the unit. The addition of vapor compression systems to the high temperature effects allows for water distillation during off-peak hours. 12 references. (J.M.J.)

54241 (A/CONF.49/P–733) NUCLEAR DESALINATION IN SPAIN. Pascual, F.; Oltra, F. (Junta de Energia Nuclear, Madrid (Spain)); Troyano, F. (Centro de Estudios Hidrograficos, Madrid (Spain)). May 1971. 16p. (In Spanish). (CONF-710901–504). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Four fossil-fired flash distillation desalting units are in operation in Spain. Great experience has thus been obtained on this basic technology. Other complementary processes are also being studied and developed. This paper shows the main features of the units and the data derived from their operation. Two studies have been of the application of nuclear energy in desalination: one corresponds to the possibility of supplying the water needs of Barcelona; the other deals with an agro-industrial-touristic complex in the Almeria area. Updated results from these studies are presented which take into account the latest technical and economical information on both the nuclear and the desalting plant areas. The technical research and development programs conducted in Spain in the field of desalination are covered, as well as the future programs. 12 references. (auth)

54242 (TID–25603(Vol.2)) PUERTO RICO ENERGY CENTER STUDY. VOLUME II. (Burns and Roe, Inc., New York. Dow Chemical Co., Midland, Mich.). Jul 1970. 401p. Dep. NTIS.

The selection of a group of product modules for the planned agro-industrial complex in Puerto Rico is reviewed. Cost considerations and production efficiency are analyzed. Process heat applications and products considered include: chemical refinery, ethylene, ethylbenzene, cumene, ethylene glycol, propylene glycol, chlorine-caustic, ethylene dichloride, calcined coke, salt, magnesium hydroxide, hypochlorite, aluminum, hydrogen and ammonia, elemental phosphorus, phosphoric acid wet, magnesium, silicon metal, acetylene and vinyl chloride, fuel reprocessing, electric furnace iron, copper refining, and heavy water. (D.C.C.)

54243 METHODS OF OPERATING A NEUTRONIC REACTOR FOR PERFORMING GAS MIXTURES AND PRODUCING HEAT FOR MULTIPURPOSES. Miller, Edward Francis. Australian Patent 406,872. 19 Oct 1970.

A method of operating a neutronic reactor to simultaneously produce chemicals and generate heat for electric power production and water desalination is described. A neutronic reactor is cooled by passing a mixture of steam and a low boiling point hydrocarbon through its active core region where they react endothermically in the presence of a catalyst to form hydrogen and carbon monoxide. The hot reformed coolant gas which discharges from the reactor is converted to carbon dioxide and hydrogen before being passed through a heat-exchange boiler where it gives up heat to generate steam. The generated steam is used as a source for the gas reforming reaction within the reactor, for power generation, and for other purposes including water desalination using known distillation techniques. (auth) (Australia)

54244 ECONOMIC IMPLICATIONS OF NUCLEAR DESALINATION ON SEAWATER CHEMICAL RECOVERY. Yee, William C. (Oak Ridge National Lab., Tenn.). pp 121-32 of Third Symposium on Salt. Vol. 2. /Rau, Jon L. (ed.). Cleveland; Northern Ohio Geological Society, Inc. (1970).

From third international symposium on salt; Cleveland, Ohio (22 Apr 1969). See CONF-690456-(Vol.2).

An economic analysis is made of several possible salt complexes that recover chemicals from the brine discharge of a nuclear desalination plant producing 1000 mgd of fresh water with a seawater concentration factor of 2. Primary product recovery involves using solar energy at an arid desert site to separate out sequentially gypsum, salt, potash and magnesium chloride by fractional crystallization. Secondary product production involves using electrical and steam energy from the desalination plant to obtain cement and sulfuric acid, caustic soda and chlorine, and magnesium metal. Caustic soda and chlorine (as hydrochloric acid) can be used to remove bicarbonate ion from seawater prior to freshwater production. Land requirements for solar evaporation are reduced by the availability of evaporator effluent as a starting material. Starting with two times concentrated (2×) seawater there is a 40% reduction in acreage for the production of solar salt; with 3× seawater, a 60% reduction. At a 10% cost of money, the cost of salt production is reduced 15% and 25%, respectively; this assumes that the cost of the undeveloped land is negligible in comparison to the land improvement cost. The processing of 3% of the brine discharge (2× seawater concentration) from a 1000 mgd plant would consume 400 MW(e) of electric power, would require a capital investment of $95 million exclusive of the nuclear reactor station, would generate an income of $40 million and would have a break-even power cost of 5.3 mills/kwhr. Seawater treatment by the NaOH-HCl method would compete with the conventional sulfuric acid method of treatment at a power cost of 4 mills/kwhr when sulfur costs $50/ton or 2.5 mills/kwhr when sulfur costs $40/ton. A cost analysis is also given for a salt complex that utilizes 6% of the evaporator effluent from the nuclear desalination unit. 21 references. (auth)

54245 PROPOSAL FOR USING NUCLEAR REACTORS AS THERMAL RADIATION SOURCES. Almenas, K. (Univ. of Maryland, College Park). Nucl. Technol.; 10: No. 1, 22-32(Jan 1971).

The feasibility of using a nuclear reactor as a thermally radiating energy source is investigated. Design parameters including radiant energy transmission, attenuation of γ and neutron fluxes, criticality and heat-transfer are evaluated. Since conclusive experimental data for nuclear and high temperature heat transfer properties are lacking, a mathematical relationship between these limiting parameters is derived and the results are presented for the whole range over which they are likely to vary. For some of the designs considered the overlap within which a thermally radiating nuclear reactor can be considered feasible is sufficiently broad to cover all possible uncertainties. It is concluded therefore that a spherical W–UO_2 cermet shell reactor, operating at a surface temperature of 2800°K is, assuming a modest extrapolation of present day materials technology, indeed feasible. (31 references) (auth)

Marine and Portable Power Reactors

Refer also to abstract 53920.

54246 (A/CONF.49/P-178) RESULTS ACHIEVED IN ITALY IN THE FIELD OF NUCLEAR SHIP PROPULSION. Barabaschi, S.; Cavaggioni, M.; Franco, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)); Cesoni, G.; (and others) (FIAT, Turin (Italy). Sezione Energia Nucleare). May 1971. 19p. (CONF-710901-186). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The design and the related development activities which have been performed for the Italian nuclear ship propulsion steam supply system are described. The results regarding the following subjects are described: core nuclear design; core thermal design; core and core support structure mechanical design; plant dynamic behavior; plant systems and equipment; and shielding. (auth)

54247 (A/CONF.49/P-236) ON THE JAPANESE NUCLEAR SHIP "MUTSU". Sasaki, S. (Japan Nuclear Ship Development Agency, Tokyo). May 1971. 15p. (CONF-710901-93). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The N. S. Mutsu was designed based upon principles to construct it with domestic technology and to ensure safety. Not only Japanese regulations but also foreign rules were introduced into the design to have the ship go on foreign routes. The reactor is pressurized water with thermal output of 36 MW, giving the main shaft 10,000 h.p. Low enriched uranium oxide clad with stainless steel is used as fuel elements. Both equipment for emergency cooling and for removal of decay heat was carefully designed to double the safety. (auth)

54248 (A/CONF.49/P-376) FURTHER DEVELOPMENT AND ECONOMIC ASPECTS OF THE INTEGRATED PRESSURIZED WATER REACTOR ON THE BASIS OF THE EXPERIENCES GAINED WITH THE OTTO HAHN. Ulken, D.; Kolb,, M.; Schumacher, W.; (and others) (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht (West Germany)). Apr 1 1971. 22p. (CONF-710901-129). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva Switzerland (6 Sep 1971).

A short description of the FDR integrated pressurized water reactor main design features such as the integration of the primary coolant pumps, the heat exchanger, and the "self-pressurization" into the pressure vessel is presented. The operating experiences of the FDR resulting from more than 10,000 operating hours and voyages of well over 100,000 nautical miles are reported, demonstrating its high reliability. Special emphasis is put on the self-controlling properties of the FDR which led to its fast maneuverability and its excellent behavior during violent motions of the ship in heavy weather. 18 references. (auth)

54249 (A/CONF.49/P-401) SHALL NUCLEAR SHIPS BE STRANDED BY LACK OF RELEVANT LEGAL PROVISIONS? Boulanger, Werner (Bundesministerium fuer Bildung und Wissenschaft, Bonn (West Germany)). Apr 1971. 12p. (CONF-710901-143). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In no field of modern technology has the legal basis been so well prepared internationally as for nuclear ships. Already in 1960, when only one civilian nuclear ship, the USSR "Lenin", was in operation, a special chapter on nuclear ships was included in the London Convention on Safety of Life at Sea. In May 1962, a Diplomatic Conference at Brussels agreed on a Convention on the Liability of Operators of Nuclear Ships. International agreements for the "Savannah" and "Otto Hahn" nuclear ships are described. International legal provisions for future nuclear ships are discussed. 21 references. (auth)

54250 (A/CONF.49/P-713) ROLE OF SMALL NUCLEAR POWER PLANTS AS SOURCES OF ENERGY IN REMOTE REGIONS OF THE USSR. Abramov, V. M.; Andreev, P. A.; Aleksenko, Yu. N.; Barskii, M. L.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 29p. (CONF-710901-418). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The waning enthusiasm regarding the prospects of small-capacity power engineering which was apparent in the middle of the sixties has recently given way to a growing interest in reactors of small and intermediate power; such reactors may be used for combined production of electric energy and heat or solely for heat production, to supply the domestic and industrial needs of isolated areas and areas undergoing development. Regions of this type are generally characterized by small populations and poor industrial development, by the scattering of power consumers and poor communications. All this explains why power for such regions is generally provided by local power systems or even by independent sources not connected to the power network. In addition, it is usually very difficult and expensive to supply fuel to these remote undeveloped areas. In remote areas with small populations, the construction of nuclear power sources offers advantages. Savings effected through the use of nuclear fuel may be sufficient to compensate for the high cost of construction. In recent years, thanks to experience gained in the design, construction and operation of atomic power stations it has become possible to regard the small-capacity power solution as an alternative means of providing energy for isolated districts; this involves the use of nuclear reactors, the technological and production problems of which have already been mastered. A satisfactory solution to the problem of developing small-capacity power production is particularly important in the Soviet Union since the areas in the far north of the USSR are unique as regards their size, the urgency of their power requirements and hence the scale on which atomic energy can be used. 13 references. (auth)

54251 (A/CONF.49/P-722) NEW ATOMIC ICEBREAKER "LENIN". Mitenkov, F. M.; Movshevich, Z. M.; Pologikh, B. G.; Sledzyuk, A. K.; (and others) (State Committee on the Utilization

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of Atomic Energy, USSR). Sep 1971. 13p. (In Russian). (CONF-710901-514). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Operation of the nuclear-powered icebreaker "Lenin" showed distinct advantages of this type with its fuel reserve as compared with a unit operating on organic fuel. Reliable and stable operation of the Lenin's reactors was noted despite pitching, vibration and shock associated with movement through the ice. A new steam-producing unit consists of two identical automatic units, each of which includes a reactor, four steam generators, four circulating pumps in the primary loop, a volume compensator, and associated equipment. Maintenance of the new units has been vastly improved. The water of the inner cooling loop circulates through a biologically shielded reservoir and possesses low activity. More recent design of the installation has made it possible to reduce the volume of liquid and solid wastes handled during maintenance. The reactor core consists of 241 cassettes located in the vertices of a triangular lattice, each cassette being composed of a bundle of rod-shaped zirconium alloy-clad fuel elements. Boron carbide control rods are operated within special zirconium guide tubes. Sixteen absorber rods form an emergency scram system. The weight of an entire steam producing unit is 2,300 metric tons, and is rated at 44,000 horse power. The operating time at full power without recharging is 11,000 to 16,000 hr. The temperature of the primary coolant at normal power level is 273°C entering the core, and 318°C at the exit ports. Operating accomplishments during Artic excursions are summarized. (KSW)

54252 INVESTIGATIONS ON THE PRIMARY REACTOR SHIELDING OF THE NUCLEAR SHIP OTTO HAHN. Fiebig, R.; Frisius, F.; Hackbarth, H.; Richter, G. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH., Hamburg). Atomkernenergie; 18: No. 1, 71-8(Aug 1971). (In German).

For a comparison to the shielding-calculations results the radiation field was measured within the primary shield of the reactor of the nuclear ship "Otto Hahn." The results of the second part of the investigations concerning the radiation intensities within the shield tank outside the pressure vessel are presented. The measured fluxes and dose rates are compared mainly to the results of the removal diffusion code Restrab. In agreement to the statement of the first part of the investigations it is found that the program is overestimating the high energy part of the fast neutron spectrum but giving a reasonable accuracy for the total fast neutron flux density. For the calculation of the γ-dose rates the lateral distribution of the capture γ-radiation sources is taken into account by a reasonable approximation. By this means a very good agreement with the measured values is obtained. 6 references. (auth)

Production Reactors

Refer also to abstract 53920.

54253 (DP-1251) ANALYSIS OF XENON OSCILLATION EXPERIMENTS. Vandervelde, V. D. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug 1971. Contract AT(07-2)-1. 31p. Dep. NTIS.

Time-dependent, three-dimensional neutron flux calculations have been performed to compare with experimental results of axial xenon oscillations in a Savannah River production reactor. The results of the calculations predict the oscillation behavior for these experiments that were least affected by other driving forces, such as control rod motion. MAPLE SYRUP and other similar codes are applicable for predicting the threshold for and the period of xenon oscillations. (8 references) (auth)

54254 INSTRUMENTATION PERFORMANCE AT THE N REACTOR. Flickinger, J. K. (Douglas United Nuclear, Richland, Wash.). pp 675.1-6 of Proceedings of the 24th Annual ISA Conference. Pittsburgh; Instrument Society of America (1969).

From twenty-fourth annual conference of Instrument Society of America; Houston, Tex. (27 Oct 1969). See CONF-691004-(Pt.4).

A brief description of N Reactor's major plant instrumentation systems is presented and a few of the measurement and control problems, their origin, and resolution are discussed. Measurement and control of water level in 12 large steam generators, 16 dump condensers and a large pressurizer vessel are discussed. Sensor problem in measurement of reactor fuel channel outlet coolant temperatures is also discussed. (auth)

Reactor Theory

54255 (A/CONF.49/P-351) THEORETICAL METHODS FOR CORE PARAMETERS DETERMINATION IN URANIUM-PLUTONIUM LATTICES. Pop-Jordanov, J.; Bosevski, T.: Matausek, M.; (and others) (Institut za Nuklearne Nauk Boris Kidric, Belgrade (Yugoslavia)). May 1971. 12p. (CONF-710901-118). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

A comprehensive review is presented of the methods for core parameters determination in uranium-plutonium lattices developed in Yugoslavia during the last few years. The main feature of these approaches is the tendency to proceed with analytical treatment as far as possible and then to include suitable numerical improvements. Pursuing this philosophy, which is generally overlooked when using large computers, fast and reasonably accurate methods were obtained. The methods contain original developments for adequate treatment of neutron spectra and cell geometry effects, especially suitable for U-Pu systems. In particular, the procedures using the energy dependent boundary conditions, the discrete energy representation, the improved collision probabilities and the Green function slowing down solutions were developed and applied. A number of results obtained by the developed methods are presented and compared with the experiments and other existing methods. 29 references. (auth)

54256 (CONF-701002-, pp 12-24) APPLICATION OF NUCLEAR STANDARDS IN THE DESIGN AND EVALUATION OF NUCLEAR REACTORS. Schmidt, Josef Johannes (International Atomic Energy Agency, Vienna (Austria)).

From Symposium on neutron standards and flux normalization; Argonne, Ill. (21 Oct 1970).

In Neutron standards and flux normalization.

The way standard neutron cross sections and data enter into reactor-design calculations is discussed, and the dependence of fast reactor design parameters, such as effective multiplication factor, breeding ratio, Doppler coefficient, and others, on standard data is investigated. From this, $\bar{\nu}_{sp}(^{252}Cf)$ and the fast ^{235}U fission cross sections are identified as particularly important standards. Furthermore, the need for reliable primary standards and for using mutually consistent standard data in reactor calculations is underlined. (45 references) (auth)

54257 OPTIMAL CONTROL OF NUCLEAR REACTOR DEPLETION. Wade, David C.; Terney, William B. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng.; 45: No. 2, 199-217(Aug 1971).

The design and operation of a nuclear reactor are posed as optimal control problems in terms of a generalized set of design objectives and a generalized control that influences the nodal material bucklings in a one-group spatially nodalized reactor model. The necessary conditions for optimality are derived by use of the Pontryagin Maximum Principle. An iterative algorithm is worked out for the resulting equations. A useful property of this algorithm is that each iteration produces an improved, consistent reactor life study for the assumed control. Therefore, the iterations may be terminated at any suboptimal yet acceptable stage. Furthermore, the designer may intervene in the iterative convergence toward the optimal control to exercise judgment and intuition not readily included in an algorithm. The approach is verified by solving a number of sample problems with the test code OPTIM. The results of these problems show that the method works and quickly gives significant improvement in the design. (auth)

54258 CONSIDERATION OF EIGENVALUE SENSITIVITY FOR A REACTOR SYSTEM. Kando, Hisashi (Musashino Electrical Communication Lab., Japan); Iwazumi, Tetsuo; Hattori, Yoshio. J. Nucl. Sci. Technol. (Tokyo); 8: No. 7, 363-70(Jul 1971).

If there is a high eigenvalue sensitivity in a nuclear reactor system to variations of the system parameters, the reactor system will be in danger of excursion. A state variable feedback system that reduces the representative eigenvalue sensitivity of the system to simultaneous deviations of the system parameters is derived. The variations of the output sensitivity and of the transient response of the system due to the addition of the feedback system thus derived are analyzed. 20 references. (auth)

54259 ENRICHED URANIUM METAL CRITICALITY CALCULATIONS. Hunt, D. C.; Coonfield, D. C. (Dow Chemical Co., Golden, Colo.). Nucl. Technol.; 12: No. 3, 260-8(Nov 1971).

The effects of varying energy group cross section sets and the space-angle mesh must be understood to evaluate critical parameters computed by the discrete-ordinates S_n method. These effects are investigated using critical mass calculations on several enriched uranium metal systems. Based on the variation of critical mass with refinement of the space-angle mesh, mesh specification criteria are deduced. The most significant criteria established for these systems is that S_n ($n \geq 16$) calculations are required. Next, the literature on fast ($E_n \geq 3$ keV) ^{235}U and ^{238}U neutron cross sections is reviewed and a seven-group cross section set in this energy range is developed. This fast set is found to reproduce to within 0.5% the measured critical masses of several fast uranium systems. Finally, group cross section sets in the resolved resonance energy ranges of ^{235}U and ^{238}U are developed according to several energy self-shielding models. A recommended set is obtained by interpolation between two of these models. This set yields critical masses in good agreement with observed critical masses for several intermediate energy metal critical systems with several ^{235}U enrichments. 26 references. (auth)

54260 PRACTICAL APPROACH TO NUCLEAR CRITICALITY SAFETY. II. CRITIQUE OF A MODEL. Lewis, William Bradley. Nucl. Technol.; 12: No. 3, 276-80(Nov 1971).

A model is fitted to experimental data by means of a normalizing factor, $\lambda(x)$, over a range of material compositions, $x_0 < x < x_1$. The fitting involves certain modifications of data points. The total discrepancy of the modifications is expressed as $\delta(x)$. To an error no greater than $\delta(x)$, a model agrees with experiment. Fitting was made to two-group diffusion theory, but the method has general applicability. (auth)

Kinetics

Refer also to abstract 52894.

54261 (A/CONF.49/P-330) NPY-COOPERATION IN REACTOR PHYSICS. Zelazny, R. (Institute of Nuclear Research, Swierk (Poland)). May 1971. 14p. (CONF-710901-203). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The main organizational concepts of the cooperation in reactor physics among Norway, Poland, Yugoslavia and IAEA, called shortly NPY-Project, established in 1964 and concluded this year are described. The scientific objectives which were the goals of this 7 years cooperation are discussed in detail. On the basis of the output of this cooperation the high-lights of the scientific, technical and organizational achievements are presented. Among them the merits of three international advanced summer schools and many seminars organized in the framework of this cooperation are discussed. Physical problems of particular interest for three cooperating parties and for the rest of the scientific community of IAEA state members, which were attacked and solved within the framework of NPY-Project, are formulated and elucidated. (auth)

54262 (IAE-1981) APPLICATION OF THE ALBEDO METHOD TO THE DESIGN AND CALCULATION OF BUNDLES OF RODS. Maiorov, L. V.; Trukhanov, G. Ya.; Frank-Kamenetskii, A. D. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 40p. (In Russian). Dep. NTIS (U. S. Sales Only).

The effectiveness is analyzed of a method for the design and calculation of multiple-rod moderator systems in which each of the micro-cells constituting the system is regarded as a black box and characterized by a set of reflection and transmission coefficients. The Monte Carlo method is used to calculate these coefficients. Various approximations are proposed within the framework of this method, and specific examples are presented to determine their accuracy by comparing them with the direct calculation of the entire system by the Monte Carlo method. All the calculations were performed on an M-220 computer. 3 references. (JPRS)

54263 (ITEF-817) XENON TRANSITION PROCESSES IN NUCLEAR REACTORS. Rudik, A. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 91p. (In Russian). Dep. NTIS (U. S. Sales Only).

Xenon transition processes are described both mathematically and in terms of the loss of thermal neutrons as a result of the large capture cross section of ^{135}Xe. The problems associated with a shift of reactor power level to another are directly related to this condition. The optimization of xenon transition processes, its mathematical treatment, Pontryagin's principle, the optimum trajectory, and boundary conditions at the terminus of the transition process are discussed. The significance of the time of the transition process and the role of spatial non-uniformity are considered. Xenon fluctuation, the stationary state, and reactor shutdown are also discussed. (K.S.W.)

54264 (JAERI-Memo-4352) EFFECTS OF SPACE DEPENDENCY ON REACTOR KINETIC ANALYSIS. Takeuchi, Eiji; Hatta, Hiroshi; Ishikawa, Michio (Japan Atomic Energy Research Inst., Tokyo). Feb 1971. 35p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Effects of space distribution of power and feedback reactivity weighting factors on reactor kinetics are investigated, using computer code EUREKA (nuclear thermal hydrodynamic point kinetic code) and EUREKA-SPACE-TEMP (modified EUREKA for space kinetics by time variable input). In power transient induced by ramp reactivity insertion, such as control rod withdrawal accident in BWR, power distribution and feedback reactivity weighting factors in core change each second with movement of the control rod, and as a consequence the induced transient power is influenced. 7 references. (auth)

54265 (RPI-328-231) PRINCIPLE OF INFORMATION FLOW FOR THE TREATMENT OF DISCONTINUITIES IN SYNTHESIS TECHNIQUES. Becker, Martin (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Science). [1971]. Contract AT-(30-1)-328. 22p. Dep. NTIS.

Discontinuous trial function methods are useful in various nuclear engineering applications. One of the problems associated with such methods is the unambiguous specification of interface conditions. The application of the asymmetric discontinuity approach to both initial-value and boundary-value problems is described. (12 references) (D.C.C.)

54266 ANALYTIC SOLUTION TO THE FLAT FLUX PROBLEM. Terney, William B. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng.; 45: No. 2, 226-30(Aug 1971).

Optimal control theory is applied to select the k_∞ distribution in a reactor core so as to minimize the neutron flux deviation from an average value while k_∞ is restricted by upper and lower bounds. (H.D.R.)

54267 DEGENERATE KERNEL TECHNIQUE AND NEUTRON THERMALIZATION CALCULATIONS IN ASYMPTOTIC REACTOR THEORY. Turinsky, Paul J.; Duderstadt, James J. (Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng.; 45: No. 2, 156-66(Aug 1971).

The substitution of a K-term degenerate kernel expansion (DKE) for the true scattering kernel in the inscattering term for neutron thermalization calculations is shown to recast the solution of the original speed dependent Fredholm integral operator equation into that of a speed-independent $K \times K$ matrix operator equation, which is well suited for numerical calculations. A DKE is constructed that rapidly converges pointwise to the true scattering kernel, preserves the total scattering cross section, and contains the correct speed structure to yield accurate solutions in neutron thermalization calculations. This DKE was employed in the numerical solution of the steady-state, time-moment, time-eigenvalue, and time-dependent neutron thermalization problems within the framework of asymptotic reactor theory. A detailed numerical investigation of the DKE approximation to the free proton gas and polyethylene scattering kernels indicated that accuracy consistent with a 32 discrete speed mesh point treatment was obtained by employing a 10-term DKE. This implies that the degenerate kernel technique reduces the size of the matrix operator equations to be solved to $\sim\frac{1}{3}$ the size required by a discrete approach, hence implying considerable computer cost reductions in neutron thermalization calculations. 27 references. (auth)

54268 APPLICATIONS OF THE DEGENERATE KERNEL TECHNIQUE TO THERMAL NEUTRON SPECTRA CALCULATIONS. Turinsky, Paul J.; Duderstadt, James J. (Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng.; 45: No. 2, 167-81(Aug 1971).

Several applications of the degenerate kernel technique (DKT) for treating the speed dependence in steady-state neutron thermalization calculations are studied both analytically and computationally. An iterative improvement technique is developed for fine thermal spectrum calculations. It is shown that the size of the degenerate kernel expansion (DKE) required to obtain consistent accuracy with a given number of discrete speed mesh points can be decoupled from the speed mesh structure by such a technique. This decoupling allows a more efficient numerical solution and hence a savings in computation time. The solution of the integral transport equation within the isotropic scattering approximation is also studied within the DKT framework. The DKT formalism allows a considerable reduction in the dimensionality of the numerical representation of this problem, hence implying reduced computation costs. Finally, the DKE was employed within the invariant-imbedding transport formalism to calculate the reflection (R) and transmission (T) probabilities for thermal neutrons incident upon a slab. Once again the DKT leads to a very considerable reduction in computation time and storage when compared with

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multigroup approaches. Numerical methods for solving the invariant imbedding-DKT equations for R and T were developed and computationally verified as both accurate and efficient. 20 references. (auth)

54269 SOLUTION OF THE NEUTRON DIFFUSION EQUATION BY SPACE–ENERGY FACTORIZATION. **Stacey, Weston M. Jr.** (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 45: No. 2, 189-98(Aug 1971).

A method is described for solving the energy-dependent neutron diffusion equation by first factorizing the flux into a spatial shape function with weak energy dependence and a spectral function, then developing coupled equations for these two functions which must be solved iteratively. Numerical procedures used to solve these equations combine internally, and in a self-consistent fashion, a fine-group spectrum calculation with a broad-group spatial calculation. Numerical examples, based on representative fast-reactor models, are presented to demonstrate that this space-energy factorization method constitutes an accurate and economical approximation. (auth)

54270 P_1 BLACKNESS THEORY FOR INFINITE CYLINDERS. **Mendelson, M. R.; Storm, M. L.** (Knolls Atomic Power Lab., Schenectady, N. Y.). Contract W-31-109-Eng-52. Nucl. Sci. Eng.; 45: No. 2, 182-8(Aug 1971).

P_1 blackness theory for infinite cylinders is developed in a manner analogous to the case of infinite slabs by defining effective diffusion theory cross sections in the "black" region which reproduce the desired boundary condition at the surface. Results of numerical analysis of a model problem are presented and the relative improvement of P_1 blackness theory over normal P_1 theory is compared with similar results for infinite slabs. (auth)

54271 CALCULATIONS OF THERMAL-NEUTRON GROUP CONSTANTS DURING BURNUP OF LIGHT-WATER-MODERATED LATTICES. **Hron, M.** (Institutt for Atomenergi, Kjeller, Norway). Nucl. Sci. Eng.; 45: No. 2, 230-2(Aug 1971).

54272 EFFECTIVE DIFFUSION COEFFICIENTS IN HETEROGENEOUS MEDIA. PART I. GENERAL THEORY. **Williams, M. M. R.** (Queen Mary Coll., London). Atomkernenergie; 18: No. 1, 31-50(Aug 1971).

Two complementary methods of calculating cell-averaged neutron diffusion coefficients in heterogeneous systems are discussed. One is based upon integral transport theory and the other on the P_N-approximation; the results are used to show the common ancestry of the many, piecemeal treatments of neutron streaming that have appeared over the years. On the basis of image pile theory for an axially uniform medium, exact expressions are derived for the axial and radial diffusion coefficients as functions of energy. A number of limiting cases for slabs and cylindricalized cells are studied, and a working procedure for making cell calculations in the diffusion approximation is discussed in detail. 29 references. (auth)

54273 TRANSPORT THEORETICAL MULTIGROUP SLOWING-DOWN. **Leuthaeuser, Klaus-Dieter** (Univ., Kiel). Atomkernenergie; 18: No. 1, 11-19(Aug 1971).

A general formalism for treating multigroup slowing-down transport equations in nonfissionable media with plane geometry is presented. The method is based on particular solutions for each inhomogeneous group equation. These solutions have to be completed by the well-known set of eigenfunctions of the source-free transport equation such that boundary and symmetry conditions are satisfied. As an example, the infinite medium Green's function problem with plane source in the first group is analyzed in detail for isotropic and linearly anisotropic scattering kernels. Explicit results are obtained for the first two groups. Solutions for higher groups are constructed successively. It is shown in general how to proceed from group i to group $i + 1$. 24 references. (auth)

54274 SPACE–TIME REACTOR KINETICS FOR HETEROGENEOUS REACTOR STRUCTURE. **Raisic, Nenad** (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). Bull. Boris Kidric Inst. Nucl. Sci., Nucl. Eng.; 21: No. 1, 1-10(Jan 1970).

The reactor kinetic equations have been formulated on the basis of the Feinberg–Galanin heterogeneous reactor theory. A set of simultaneous differential equations is obtained in this way, each equation describing the time behavior of the neutron flux at the position of a single fuel element in a heterogeneous reactor structure. The solution for space-time distribution of the neutron flux is given for the step change in reactivity as well as for the pulsed neutron source. On the same principles the zero power reactor transfer function has been derived. 8 references. (auth)

54275 KINETIC DISTORTION EFFECT IN PULSED-NEUTRON REACTIVITY MEASUREMENTS. **El-Zeftawy, Medhat Mahmoud.** **Berkeley, Calif.; Univ. of California (1970). 135p. University Microfilms Order No. 71-15,758.**

Thesis.

A theoretical and experimental investigation was undertaken of the kinetic distortion effect in the TRIGA-Mark-III reactor. The kinetic distortion (or space-dependent) correction factor in pulsed-neutron reactivity measurements results from a difference in shape between the fundamental prompt and delayed modes in the core and in the reflector. The two-dimensional reactor code EXTERMINATOR-2 was used in the (r,θ)-geometry to describe the TRIGA-Mark III with an asymmetric reflector. Measurements were made of the prompt and delayed response of the system with the aid of a pulsed-neutron generator placed external to the core. Calculations indicate that the kinetic distortion effect is relatively small in water-reflected reactors, even in the far subcritical case, and the measurements are in qualitative agreement. It is concluded that standard pulsed-neutron methods yield a less spatially dependent reactivity in the TRIGA-Mark III if a relatively small kinetic distortion correction factor is applied. (Diss. Abstr. Int., B)

54276 NEW CALCULATIONAL METHOD FOR SPACE–ENERGY–ANGULAR DEPENDENT REACTOR KINETICS. **Dodds, Harold Lebron Jr.** **Knoxville, Tenn.; Univ. of Tennessee (1970). 97p. University Microfilms Order No. 71-17,726.**

Thesis.

In order to aid the interpretation of kinetic experiments in nuclear reactors, a new calculational method for solving the zero-power reactor kinetic equations in the frequency domain was developed. The algorithm that was developed is valid for either multigroup diffusion theory or discrete ordinate transport theory in one-dimensional slab geometry. The numerical technique that is used employs a combined transfer-scattering (or response) matrix concept which includes spatially distributed extraneous sources. The technique is explicitly designed to control truncation and round-off error problems. Results calculated using the new technique were compared with experimental results for a D_2O moderated, natural-uranium fueled, subcritical assembly. Good agreement with experiment was achieved. A comparison with results calculated independently using a more conventional calculational technique was also performed. Excellent agreement was achieved in this comparison. Finally, in order to demonstrate its usefulness, the method was utilized in a theoretical investigation into the validity of using the point model to describe the subcritical kinetics of a symmetrically reflected, fast reactor. The results of this theoretical study indicated that, in general, the point model was not valid for interpreting experimental results obtained with a detector located in the reflector and was only approximately valid for a detector located in the center of the core. (Diss. Abstr. Int., B)

54277 NEUTRON WAVES IN REFLECTED REACTORS. **Shani, Gad.** **Ithaca, N. Y.; Cornell Univ. (1970). 223p. University Microfilms Order No. 71-14,594.**

Thesis.

Neutron wave propagation and reflection at the boundary between a water moderated multiplying region and a pure water region were investigated experimentally and compared to calculated results. The neutron waves were produced by two methods; a 5¢ reactivity poison oscillator and a ^{252}Cf neutron source surrounded by a thermalization box and a rotating shutter. Neutron waves propagated across the slab core and were transmitted and reflected by the core-reflector interface. The amplitudes and phases of these waves were measured as a function of position at frequencies from 1 cps to 100 cps. It was found that one group diffusion theory is not adequate to describe neutron wave phenomena in water moderated assemblies. Using two group diffusion theory with an oscillating source, the neutron density is given adequately by the one dimensional form for each group and region: $F_1(X) + F_2(X)\, e^{i\omega t}$. The complex neutron density, $F_2(X)$, is given by an analytic solution for the two region approximation when the decay of the delayed neutron precursors is ignored. A four region, two group, time dependent diffusion theory numerical solution including delayed neutrons also gives good agreement with the experimental results. (Diss. Abstr. Int., B)

54278 DETECTION EFFICIENCY DEPENDENCE OF SUBCRITICALITY MEASUREMENTS BY THE POLARITY SPECTRAL COHERENCE METHOD. **Ackermann, N. J. Jr.; Buhl, A. R.** (Oak Ridge National Lab., Tenn.). Nucl. Technol.; 12: No. 3, 320-3(Nov 1971).

The polarity spectral coherence method (PSCM) of Seifritz has been proposed for measuring the subcritical reactivity of a nuclear reactor. However, due to the nature of the PSCM measurement technique, a systematic error in the subcritical reactivity measurement may occur because of unexpected changes in the neutron detection efficiency. This error is assessed through the development of the appropriate equations, and a hypothetical measurement in a typical liquid-metal fast breeder reactor is numerically evaluated. The results demonstrate that the PSCM is subject to systematic errors which can be quite serious and which must be considered when the PSCM technique is used. 9 references. (auth)

Dynamics

Refer also to abstract 54228.

54279 APPLICATION OF THE SPECTRAL SYNTHESIS METHOD TO THE ANALYSIS OF SPATIALLY DEPENDENT FAST-REACTOR TRANSIENTS. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 45: No. 2, 221-6 (Aug 1971).

Experimental Applications

54280 (A/CONF.49/P-310) DEVELOPMENTS IN PULSED NEUTRON SOURCE STUDIES OF HETEROGENEOUS MODERATOR SYSTEMS. Grosshoeg, G.; Sjoestrand, N. J. (Chalmers Tekniska Hogskola, Goteborg (Sweden). Institutionen for Reaktorfysik). May 1971. 12p. (CONF-710901-269). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The conditions for obtaining discrete decay constants in pulsed source experiments on homogeneous and heterogeneous moderator systems are discussed. In heterogeneous systems the neutron flight time in cavities and channels will cause a large influence of the continuum modes on the die away of the neutron population. This makes the interpretation of pulsed experiments difficult, but it also opens up new possibilities for experimental studies of a continuum region, e.g., by using hydrogeneous systems. The influence of the continuum can be varied through the introduction of absorbers in the body under study, and by complete elimination the results from measurements on heterogeneous systems can be evaluated as in the classical pulsed method. A determination of the interaction parameter between two discs shows that the absorber method can be applied to problems of great practical importance. The experimental work performed so far is reviewed, and possible future developments are discussed. 40 references. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 51552, 51636, 51673, 51679, 51720, 51736, 51742, 51784, 51789, 51797, 51844, 51933, 51950, 52294, 52318, 52355, 52409, 52428, 52431, 52432, 52435, 52474, 52481, 52485, and 52487.

54281 (A/CONF.49/P-295) STUDIES OF FUEL-CLAD MECHANICAL INTERACTION AND THE RESULTING INTERACTION FAILURE MECHANISM. Rolstad, E.; Knudsen, K. D. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Jun 1971. 18p. (CONF-710901-471). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Experiments using differential transformer elongation detectors to measure the fuel and cladding length changes of Zircaloy-2 clad UO_2 fuel rods during irradiation support the following explanation: When a fuel rod is brought to power for the first time, the fuel pellets will change shape from flat ended cylindrical bodies to hourglass-shaped bodies with convex ends. Radial cracks will develop and affect the pellet shape. The axial and radial thermal distortion of the crack pieces make their peripheral corners interact first and hardest with the cladding when power is increased. This local application of the interaction forces results in axial and tangential strain concentrations at the pellet to pellet interfaces. Each of these local strains is very small, but they add up to give a measurable increase in the cladding length and in the clad diameter ("bambooridges") near the pellet interfaces. (auth)

54282 (A/CONF.49/P-314) POWER INCREASES AND FUEL DEFECTION. Mogard, H. (Aktiebolaget Atomenergi, Studsvik (Sweden)); Aas, S. (Institutt for Atomenergi, Kjeller (Norway)); Junkrans, S. (ASEA-ATOM, Vasteras (Sweden)). Jun 1971. 15p. (CONF-710901-271). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

In order to establish the safe operating range for power increments a series of fuel irradiation experiments were carried out with fuel rods of standard design and material selection at various burnup levels in the range of 5,000–30,000 MWd/t U. The final power raising tests were carried out on single fuel rods in the pressurized water loops of R2 at Studsvik, while the pre-irradiations were performed in the experimental reactors of Agesta and Halden. A set of defect-development curves is presented, indicating the safe operating limits for incremental power rises at fast and moderate rate of increase. The clad cracking mechanism is discussed in terms of, e.g., design and materials parameters, and related to the irradiation history. Suggestions for improvements of fuel performance from this failure aspect are put forward. 16 references. (auth)

54283 (A/CONF.49/P-315) SOME IRRADIATION STUDIES OF FUEL CLAD INTERACTION AND CLAD CRACKING. Djurle, S.; Lysell, G.; Mogard, H. (Aktiebolaget Atomenergi, Studsvik (Sweden)). May 1971. 15p. (CONF-710901-272). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Summaries are given of a fuel irradiation experiment (IFA-21) which failed after irradiation to a maximum burnup of about 12,000 MWd/t-U in the Halden Boiling Water Reactor, and of irradiation experiments performed in the R2 reactor at Studsvik. These latter experiments were aimed at reproducing the ridge deformation and cracking which was experienced for IFA-21, and to clarify the influence of rod parameters, increased heat rating after embrittlement of the cladding, and rod power cycling. After successful irradiation to a burnup of about 11,000 MWd/t-U with 5,800 power cycles for one 4-rod bundle and only the normal shut-down cycles for another identical bundle, the rods were examined non-destructively. Some of the rods from these two bundles were combined to form a new bundle which was brought to a linear heat rating in excess of that which the rods had experienced earlier. This caused the circumferential ridges to increase and led to failure of one of the rods with cracking at the ridge positions in the same manner as for the test assembly IFA-21. The failure mechanism of the fuel rods is discussed in brief with reference to a metallographic study of the cracked clad regions. (auth)

54284 (A/CONF.49/P-431) PHYSICAL AND TECHNICAL PRINCIPLES OF CREATING ATOMIC POWER STATIONS WITH FAST NEUTRON GAS REACTORS COOLED BY DISSOCIATING N_2O_4. Krasin, A. K.; Nesterenko, V. B.; Sinev, N. M.; Slizov, V. P.; (and others) (State Atomic Energy Committee, USSR). Jul 1971. 23p. (CONF-710901-379). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Theoretical and experimental investigations have revealed a number of important properties of dissociating gases. Physicochemical properties of dissociating N_2O_4 permit an organized condensation cycle with the following lower condensation parameters: pressure range of 1.4 to 1.6 abs. atm., temperature range of 27 to 35°C, and a high thermodynamic efficiency due to inversive chemical reactions participating in heat generation. The condensation cycle parameters, gas density values and heat drop values allow to considerably increase the power at one exhaust in N_2O_4 turbines and to design single-shaft turbines with a metal capacity several times lower than that of a steam turbine. 11 references. (auth)

54285 (A/CONF.49/P-496) TECHNICAL PROBLEMS AND ECONOMIC PROSPECTS ARISING FROM THE ALTERNATIVE METHODS OF USING PLUTONIUM IN THERMAL AND FAST BREEDER REACTOR PROGRAMMES. Marsham, T. N.; Bainbridge, G. R.; Fell, J.; Iliffe, C. E.; (and others) (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). May 1971. 13p. (CONF-710901-220). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The methods available for calculating fuel requirements for recycling plutonium in thermal reactors are first described, comments are given on their likely accuracy and results presented from calculations on plutonium flows and isotopic concentration effects for a range of gas-cooled and water-cooled thermal reactors. The general conclusions are discussed and related to other practical aspects of the use of plutonium in thermal reactors, including fuel fabrication and reprocessing requirements, reactor design, operational and fuel management problems. Similar information is then presented on the use of plutonium in sodium cooled fast reactors for metal oxide and carbide fuels. The case is considered for initiating fast reactors with ^{235}U. Conclu-

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sions are drawn about the effects of plutonium isotopic compositions on the initial core and feed requirements for different reactor systems and the re-use of rejected material. The logistic and economic consequences of recycling plutonium and its value in thermal or fast reactors are assessed. (auth)

54286 (A/CONF.49/P-704) RADIATION RESISTANCE OF ABSORBER MATERIALS FOR NUCLEAR REACTORS. Goltsev, V. P.; Guseva, T. M.; Ponomarenko, V. B.; Nevrotin, V. K.; (and others) (State Atomic Energy Committee, USSR). Jun 1971. 22p. (CONF-710901-480). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The kinetics of gas evolution is studied: diffusion coefficients for helium in boron materials are determined and gas evolution mechanism under irradiation is suggested. The dependence of swelling upon boron-10 burnup, temperature and annealing time is presented. A diagram of radiation swelling of (n, α) absorbers is proposed as a new characteristic of radiation damage. Some recommendations for the use of studied materials in control systems of nuclear reactors power plants are given. 4 references. (auth)

54287 (BNWL-1608) STUDY OF THE REACTIVITY EFFECTS OF FINITE PuO_2 PARTICLE SIZES IN MIXED PuO_2–UO_2 NUCLEAR FUELS. Vaughn, A. D. (Battelle Pacific Northwest Labs., Richland, Wash.). Aug 1971. Contract AT(45-1)-1830. 104p. Dep. NTIS.

The infinite medium neutron multiplication factors of separate UO_2–2% PuO_2 (8% ^{240}Pu) fuel rods containing plutonium oxide ranging between a solid solution state to particle sizes of 330 microns respectively have been measured in the PCTR. Due to the non-homogeneity of the experimental fuel rods, a special set of aluminum foils containing plutonium oxide particles were utilized to obtain the relative neutron production and absorption rates in the experimental fuel assemblies. The reactivity worths of the mixed oxide rods, measured in the PCTR, and the relative absorption rates determined from the foil data indicated the fuel rods were not uniformly enriched. Therefore, the rods were analyzed for enrichment content by gamma scanning measurements which were normalized to chemistry samples to derive corrected plutonium content in each test rod. A number of theoretical calculations were performed in conjunction with the experimental measurements to aid in the analysis and interpretation of the experimental results. These calculations were repeated for water and graphite lattices other than the experimental model to derive the particle effects that can be expected in different reactor types. A discussion of the theoretical results is presented. 30 references. (auth)

54288 (GEAP-13703) EFFECTIVE THERMAL CONDUCTIVITY OF PuO_2–UO_2 AT HIGH BURNUPS. Craig, C. N.; Krankota, J. L.; Baily, W. E. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Mar 1971. Contract AT(04-3)-189. 49p. Dep. NTIS.

The integral conductivity of $(Pu_{0.2}U_{0.8})O_{2.00}$ from 1200°C to the temperature of melting was determined by re-irradiating a fuel pin at a peak power of 31 kW/ft following a steady-state irradiation to a burnup of 75,000 MWd/Te in the reflector of the Materials Test Reactor (MTR). The final high power irradiation was carried out in the VH-4, "hydraulic rabbit", facility of the MTR. The $\int k d\theta$ calculated from the fuel surface temperature (1200°C) to melting was 42.8 ± 6.4 W/cm. Comparison of this value with data on the $\int k d\theta$ to melting of $(Pu_{0.2}U_{0.8})O_{2.00}$ irradiated to low burnups showed that within the experimental error of the experiments no significant change in the $\int_{1200}^{T_m} k d\theta$ of $(Pu_{0.2}U_{0.8})O_{2.00}$ occurred at a burnup of 75,000 MWd/Te. 6 references. (auth)

54289 (JPRS-53800, pp 205-14) FORMING THE STRUCTURE OF THE CORE OF FUEL ELEMENTS OF VIBROPACKED POWDERED URANIUM DIOXIDE IN THE PROCESS OF IRRADIATION. Lebedev, I. G.; Samsonov, B. V.; Spiridonov, Yu. G.; Tsykanov, V. A. Translated from pp 171-8 of Radiatsionnaya Fizika Tverdogo Tela i Reaktornoye Materialovedeniye, Atomizdat, Moscow, 1970.

Short-term irradiations of UO_2 powder were carried out in the SM-2 reactor to determine the time and conditions for forming the core of UO_2. The thermophysical characteristics (temperature distribution, thermal conductivity, density, integrals of thermal conductivity) were determined during the irradiation. The different zones in the cross-section structure are described. The integral of thermal conductivity and the mass transport process are discussed from the viewpoint of minimum axial shift during reactor operation. (D.L.C.)

54290 (N-71-17932) SHAPED THERMAL NEUTRON FLUX FILTERS FOR AN IN-PILE TEST CAPSULE. Ford, C. Hubbard (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar 1971. 19p. (NASA-TM-X-2196; E-5756). NTIS.

Flux tailoring filters are necessary to achieve uniform, flat reaction rates for configurations of test capsules to be irradiated in high thermal flux test reactors. The shaping of filters was studied by an experimental method using (alpha,n) neutron sources in water media. The design objective was to achieve acceptably flat reaction rates along the axes of the test capsules when the unperturbed flux has a steep gradient. The flat filtered reaction rates finally attained were only slightly lower than those due to the lowest thermal flux level present before the tailoring filters were introduced. (auth) (STAR)

54291 (RT/ING-71-4) HOW TO DIMENSION A TORISPHERICAL HEAD FOR NUCLEAR CONTAINMENT VESSELS. Cesari, F.; Palmieri, D. (Comitato Nazionale Energia Nucleare, Rome (Italy)). 3 Mar 1971. 51p. Dep. NTIS (U. S. Sales Only).

Information useful in the conceptual project of torispheric heads is presented. Calculation aids needed to rapidly analyze the possible alternatives are included. The knucle radius R′ and the junction torus to crown angle Θ_c are analyzed. Some geometrical quantities, as thickness, weight, surface, and volumes are numerically calculated for various skirt diameter comprised in the range 6 to 30 meters. Graphs of all data calculated are supplied; also, nomographs are proposed to facilitate the immediate evaluation of more geometric alternatives because they are applicable to all the normal torispheric shapes. Considerations deduced by short stress analysis and by approximate cost investigation are presented to guide the technicians to a logical choice of torispherical head. 6 references. (auth)

54292 (UILU-ENG-71-2019) SHEAR STRENGTH OF END SLABS WITH AND WITHOUT PENETRATIONS IN PRESTRESSED CONCRETE REACTOR VESSELS. Civil Engineering Studies: Structural Research Series No. 380. Karlsson, B. I.; Sozen, M. A. (Illinois Univ., Urbana. Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26; Subcontract 2906. 367p. Dep. NTIS.

The different modes of failure for vessels consisting of a cylinder bounded by flat end slabs were investigated. Small-scale specimens were tested. The major variables were ratio of the thickness of the end slab to the interior diameter of the vessel, penetrations in the end slab, and the longitudinal and circumferential prestressing forces. Presented are the results of six tests of pressure vessels, conducted primarily to investigate the shear strength of the end slab and the effect of penetrations on the shear strength. Observations indicated that the end slab fails in shear as a result of the following mechanism: A critical inclined crack develops tending to transform the end slab into a dome. Collapse occurs by failure of the concrete in the dome. A method was developed to estimate the shape of the dome and the failure load, based on finite-element analyses of the end slab and a failure criterion for concrete subjected to triaxial stresses. (auth)

54293 DOUBLE CONTAINER REACTOR VESSEL. Fletcher III, William D. (to Combustion Engineering, Inc.). U. S. Patent 3,578,564. 11 May 1971. Filed 31 Oct 1968.

Means for suspendedly mounting a double container reactor vessel within a vessel cavity formed in a foundation structure in a manner such that, in the event of failure of the outer vessel in any location, the inner vessel will remain secured to the foundation structure are described. The means comprises the provision of radial flanges on the shells and closure covers of the inner and outer container vessels arranged such that the inner vessel flanges are retained in sandwiched relation between the opposing faces of the outer vessel flanges. Annular shoulder means are provided on the foundation wall to vertically support the assembled vessel structure by engagement with the outer vessel shell flange. An annular lock ring releasably attached to the foundation presents a bearing face adapted to engage the outer vessel closure cover flange to prevent upward movement of the retained flanges in the event of a reactor accident. (auth)

54294 NUCLEAR REACTOR INSTALLATION. Isaac, Peter (to Atomic Energy of Canada Ltd.). U. S. Patent 3,583,892. 8 Jun 1971. Filed 15 Apr 1968.

A fueling machine operates in a fueling vault arranged underneath a reactor for loading and unloading fuel channels extending into the fueling vault. A maintenance bay is arranged adjacent to the fueling vault and separated therefrom by a door and a shielding gate. Hydraulic pressure required for the various motions of the fueling machine is supplied via a plurality of cables connecting the fueling machine to a fixed point in the maintenance bay. In order not to impede the motion of the fueling machine, the cables are suspended on a post mounted on a carriage supporting the fueling machine as well as from a trailer engaging a pair of rails that extend across the maintenance bay. The trailer has an extended portion which serves to guide the cables through the passage between the fueling vault and the maintenance bay and to cooperate with the shielding gate, when the fueling machine is in the fueling vault. (auth)

54295 MONITORING THE REACTIVITY OF NUCLEAR REACTORS. (to Interatom, Internationale Atomreaktorbau, GmbH). British Patent 1,238,823. 14 Jul 1971. Priority date 13 Mar 1969, Germany.

REACTIVITY—monitoring by reactor control systems, process computer for continuous
REACTOR CONTROL SYSTEMS—reactivity monitoring by, process computer for continuous (H.D.R.)

54296 APPARATUS FOR CONVEYING SPHERICAL FUEL ELEMENTS IN NUCLEAR REACTORS. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,239,304. 14 Jul 1971. Priority date 1 Jul 1967, Germany.

REACTOR LOADING MACHINES—design with interchangeable component units for handling spherical fuel elements
REACTORS, PEBBLE BED—loading machine for, interchangeable component unit design for (H.D.R.)

54297 LOW PARASITIC CAPTURE FUEL ASSEMBLY STRUCTURE. (to Westinghouse Electric Corp.). British Patent 1,238,143. 7 Jul 1971. Priority date 19 May 1969, United States.

REACTOR FUEL ELEMENTS—design with stainless steel grid members supporting Zircaloy control rod guide tubes (H.D.R.)

54298 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Baddley, Albert Harold; Webb, John (to United Kingdom Atomic Energy Authority). British Patent 1,234,570. 3 Jun 1971. Filed 26 Sep 1967.

Reference is made to reactor shutdown means. An object of the system described is to provide shutdown equipment that will be largely unaffected by core damage or distortion. The system is particularly applicable to reactors which have a rotatable shield above or below the core for refueling purposes, such as the Dounreay PFR type. The equipment comprises at least one rigid tube penetrating the shield and reactor core, and a shutdown element that is freely movable in the tube. Mechanism is provided in or on the shield for insertion into or removal of the shutdown element from the core. The tube is withdrawable from the core to enable the shield to be rotated. Means are also provided for preventing withdrawal of the tube from the core unless the reactor is maintained in the shutdown condition by other control means. The shutdown element may be flexible, so as to be movable in the tube despite some distortion. Where the shield is located above the core the lower end of the tube may extend below the core and contain means to arrest the shutdown element after gravity fall for rapid shutdown. With liquid cooled reactors liquid coolant may be used to assist in arresting the shutdown element. (UK)

54299 SHEATHED HEATING ELEMENT. Elberg, Salomon (to Commissariat a l'Energie Atomique). French Patent 2,031,694. 9 Nov 1970. Filed 24 Feb 1969. (In French).

A sheathed, electrical heating element suitable for high thermal flux uses is described. It is designed for the experimental investigation of sheaths suitable for nuclear reactor fuel elements. It consists of a cylindrical sheath, a plug sealing one end of the sheath and current inlets. A heating resistor consisting of two concentric half-tubes, a metallic plug for closing the electric circuit and a cylinder made of a powdered insulating material inserted between the half-tubes are included inside the sheath. An electrically insulating material, with a good thermal conductivity, is inserted between the resistor, the sheath and the powder cylinder. A thermocouple is placed inside the grooves arranged at the periphery of the sheath. (France)

54300 APPARATUS FOR MONITORING MOVING BODIES IN A SELF-CONTAINED DISTRIBUTING SYSTEM. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,235,453. 16 Jun 1971. Priority date 18 Jan 1969, Germany.

DISPLACEMENT GAGES—design parameters of sound transducer, for reactor loading machines
REACTOR LOADING MACHINES—position indicators for, description of sound transducer (D.C.C.)

54301 COVERS FOR REINFORCED CONCRETE PRESSURE VESSELS. Eggeler, Ewald; Stuger, Rudolf (to Siemens Aktiengesellschaft). British Patent 1,235,149. 9 Jun 1971. Filed 24 Jul 1968.

The cover assembly described has the general shape of a frustum of a cone and comprises a number of separate units that are secured together with the smaller diameter end of the frustum towards the outside of the pressure vessel and with lateral surface positions engaging correspondingly shaped surface portions bounding the access opening of the pressure vessel, each unit having the general shape of a sector of the frustum. Each unit may have teeth that engage in mating recesses in an adjacent unit. The units may be formed with bores through which prestressing cables extend for securing the units together and strutting may be provided to assist in resisting the effect of pressure acting on the cover assembly when the vessel is pressurized. Ram devices may be located inside the pressure vessel for supporting the cover units before they are secured together. (UK)

54302 IMPROVEMENTS RELATING TO SCRAM FACILITIES FOR NUCLEAR REACTORS. Strong, Keith Thomas (to Fairey Engineering Ltd.). British Patent 1,234,190. 3 Jun 1971. Filed 13 Dec 1967.

A control element drive mechanism is described that can be set up for use either as a normal control mechanism with scram fuel element withdrawal means, or by a simple conversion with scram safety element insertion means. The drive mechanism provides normal low speed drive and rapid scram drive. The rapid drive unit is reversible to effect the foregoing conversion. (UK)

54303 FUEL ELEMENT FOR HIGH TEMPERATURE NUCLEAR REACTOR. (to Australian Atomic Energy Commission). British Patent 1,240,250. 21 Jul 1971. Priority date 5 May 1969, Australia.

BERYLLIUM OXIDES, BeO—$BeO-ThO_2-UO_2$, preparation of fine grain matrixes for reactor fuels, process for
—$BeO-PuO_2-ThO_2-UO_2$, preparation of fine grain matrixes for reactor fuels, process for
—$BeO-PuO_2-UO_2$, preparation of fine grain matrixes for reactor fuels, process for
—$BeO-PuO_2-ThO_2$, preparation of fine grain matrixes for reactor fuels, process for
REACTOR FUEL ELEMENTS—production process for spherical, with mixed oxide fuel in beryllium oxide matrix (H.D.R.)

54304 JET FORCE STRENGTH OF REACTOR CONTAINMENT VESSELS. Hamada, Kunio; Yoshinaga, Toshiaki; Hayashi, Tsutomu; Ukaji, Hideo (Hitachi Ltd., Ibaraki, Japan). Hitachi Hyoron; 51: 599-602(Jul 1969). (In Japanese).

When the supposed fracture accident of the piping contained in a containment vessel occurs, it is considered that jet force acts on the container by the release of high-pressure water. A full-sized model experiment was conducted on the resistance to the hypothesized jet force of the steel dry well of pressure-suppression type. For this experiment, the design condition for an actual container vessel was used. Jet force was imposed on two types of spherical plates with and without an eccentric penetration nozzle. Displacement and strain were measured. As a result, when the plates fractured, the center of the plates where the jet force acted was displaced 260 and 236 mm, and the rupturing jet force was 731 and 665t for the plates with and without a nozzle. Considering this result and the fact that the gap between a container and shielding concrete is 50 mm maximum, even if the safety factor is selected as 4, the design of the dry well is reasonable, due to the backup concrete. (Japan)

54305 EFFECTS OF EARTHQUAKES ON NUCLEAR CONTAINER VESSELS. Nakao, Yoshiaki (Mitsubishi Heavy Industries, Ltd., Hiroshima. Hiroshima Technical Inst.); Kimoto, Kenichiro; Katayama, Masatoshi; Satake, Masaru. Koatsuryoku; 8: 1933-8(Mar 1970). (In Japanese).

Four experiments were performed on: (1) reduced-scale ($^1/_{34}$) models made with celluloid substituted for steel and paraffin for concrete, (2) a supplementary experiment examining the effect of reinforcing ring corresponding to annular seal and crane guarder supporting concrete, (3) static experiment on a steel-made $^1/_{20}$ reduced scale model, and (4) artificial earthquake experiment on a steel model. The following results were obtained: (1) For the behavior of container vessel at the time of earthquake, the vibration not only by cantilever, but also by shell must be considered. (2) Vibration as a shell can be calculated by making it to be equivalent to both edges supporting cylindrical shell. (3) Due to the vibration mode as a shell, air-lock at the nozzle suffers about 5 via 6 times larger acceleration than the base. (4) Real local stresses at the nozzle are almost equal to stresses induced by statistically loading the same force as inertia force by earthquake, etc. (Japan)

54306 METHOD OF FITTING A WIRE HELICALLY TO A CYLINDRICAL FUEL ELEMENT Brard, Jean Claude; Cayol, Andre; Saintillan, Joseph (to Commissariat a l'Energie Atomique).

British Patent 1,238,148. 7 Jul 1971. Priority date 19 Jun 1969, France.

REACTOR FUEL ELEMENTS—spacers for, method for securing ends of wire-wrap (H.D.R.)

54307 SYSTEM FOR MARKING OF OBJECTS, IN PARTICULAR FUEL ELEMENTS IN NUCLEAR REACTORS. Crutzen, Serge; Warnery, Michel; Faure, Jacques (to EURATOM). British Patent 1,241,287. 4 Aug 1971. Priority date 10 Jul 1969, Germany.

NUCLEAR MATERIALS MANAGEMENT—fuel element identification marking, system of magnetic inclusions for
REACTOR FUEL ELEMENTS—identification marking of, system of magnetic inclusions for (H.D.R.)

54308 USE OF SMALL MODELS IN DESIGN AND ANALYSIS OF PRESTRESSED-CONCRETE REACTOR VESSELS. Corum, J. M. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Des.: 16: No. 3, 301-42(1971).

A series of small prestressed-concrete reactor vessel (PCRV) models was analyzed and tested to investigate the suitability of small-scale ($\leq$1/20) mortar models and epoxy models for determining elastic stress distributions and cracking and failure modes of concrete vessels, and to demonstrate the relative accuracy of two- and three-dimensional elastic finite-element structural analyses of PCRV's. In addition to a small concrete vessel that served as the prototype, there were two small-scale mortar models, a prestressed epoxy model, and a simple axisymmetric epoxy model. The test results from each model were compared with those from the other models and with finite-element predictions. The prototype and the two mortar models were tested to failure with internal pressure. The prototype and one mortar model were pressurized hydraulically, but the other mortar model was tested pneumatically to examine possible differences in structural behavior. The epoxy models were tested in the elastic range only. Structural behavior of the small-scale mortar models closely duplicated that of the concrete prototype. The behavior characteristics of the two mortar models indicated that failure, whether caused by pneumatic pressure or hydraulic pressure, was gradual and not catastrophic. Both two- and three-dimensional finite-element analyses were used to analyze the models, and comparison of the predicted behavior with test results showed reasonably good agreement, even with the two-dimensional analyses, thus demonstrating the reliability of the finite-element computer analyses currently being used for evaluating PCRV's. (18 references) (auth)

54309 NUCLEAR FUEL ROD HAVING AN OFFSET PLENUM. Hines, Douglas P. (to United States Atomic Energy Commission). U. S. Patent 3,586,603. 22 Jun 1971. Filed 10 Oct 1968.

A plenum design is described for non-vented or vented nuclear fuel which allows for a reduction in the core coolant pumping requirements from the conventional plenum configuration of fuel pins or rods. This is accomplished by offsetting the plenum region of the fuel pin and grouping several of the plena such that they nest together. The flow regions left between the small bundles of plena offer less resistance to flow and thus reduce the core pressure drop. The plenum configuration can be utilized in sodium-cooled, steam-cooled and gas-cooled reactors. (Official Gazette)

54310 STRUCTURAL MECHANICS IN REACTOR TECHNOLOGY. VOL. 1. REACTOR CORE. PART C. FUEL AND CLADDING. Preprints of the First International Conference, Berlin, Germany, 20–24 September 1971. Jaeger, Thomas A. (comp.). Luxemburg; Commission of the European Communities (1971). 256p. (In German and English). (CONF-710903-(Vol.1)(Pt.C)).

Separate abstracts are presented for 16 articles on design and performance requirements of reactor fuel elements and reactor fuel element cladding. (D.C.C.)

For abstracts of individual papers see: 54111–54117 and 54311–54319.

54311 NUCLEAR STRUCTURAL GROWTH INDUCED BY RATCHETTING. Hibbeler, R. C. (Youngstown State Univ., Ohio). pp C1/6.1-17 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

The progressive growth of a structural material, subjected to a cyclic heat flux and sustaining a load, is called thermal ratchetting. The increment of growth developed during each thermal cycle is caused by either plastic yielding or creep of the material. An investigation of this phenomenon is presented which applies to nuclear structural components in the form of thin cylindrical shells sustaining an internal pressure. Using different models to account for the stresses in the hoop direction, an analysis is presented which forms a useful basis for determining the allowable stress conditions necessary to prevent ratchetting. When ratchetting occurs, this analysis gives a prediction of the ratchetting growth during each thermal cycle. An exact method of analysis accounting for a triaxial stress condition in the material is also presented. The results using the simple models for representing the ratchetting behavior are then compared with the exact analysis. 5 references. (auth)

54312 METHOD OF ANALYSIS FOR THE CREEP BUCKLING OF TUBES UNDER EXTERNAL PRESSURE. Wilson, W. K. (Westinghouse Electric Corp., Pittsburgh). pp C2/3.1-15 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

A numerical method for the creep buckling of long circular thin-walled cylinders which are initially out-of-round and subjected to uniform external pressure is presented. It is assumed that the initial out-of-roundness and subsequent deflections are independent of the axial coordinate and that the initial stress state is elastic. The method eliminates many of the major assumptions previously used and can handle any combination of the strain or time hardening laws and the Mises or Tresca flow rules. The method is easily computerized. A number of specific examples are studied for 15% cold worked Zircaloy-2. The results indicate that the calculated buckling times are highly dependent upon the hardening law and flow rule used. 7 references. (auth)

54313 APPLICATION OF VARIATION PRINCIPLES IN CREEP MECHANICS TO CREEP DISTORTION PROBLEMS IN FUEL ELEMENT CLADDINGS. Malmberg, T. pp C2/4.1-17 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Two general variational principles are discussed which are applicable to creep problems. They are formulated for small strains but finite rotations. The corresponding relations are: a nonelastic viscous solid (e.g. fully developed secondary creep), and a solid having simply additive elastic and creep strain rates. On the basis of these theorems several variational principles for thin shells are formulated assuming small strains but moderately large rotations. The theory is within the frame of the Kirchhoff–Love hypothesis. Using the Ritz method one principle is applied to the problem of creep collapse of a long fuel element cladding under external pressure. The temperature field is assumed to be rotationally as well as nonrotationally symmetric. 20 references. (auth)

54314 STRESS DISTRIBUTION IN LONGITUDINALLY RIBBED FUEL ELEMENT CLADDINGS. Krieg, R. (Kernforschungszentrum, Karlsruhe, Ger.). pp C2/5.1-16 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971). (In German).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

The stresses in fuel element claddings are produced by fission gas, fuel, and coolant pressures, differential thermal expansions, and possibly by irradiation induced differential swelling of the cladding material. The elastic stress distribution is well known and easily obtained in rotationally symmetric fuel element claddings. However the stress analysis of claddings having integrated fins in the axial direction needs a considerably larger effort; but such an investigation is necessary because of possible stress concentrations at the roots of the fins. A numerical method is presented which is based on Airy's stress function and suitable trigonometric series. The calculations indicate that this method gives good results for the stress distribution, if the root radius of the fins is not too small. 11 references. (auth)

54315 BUCKLING OF A STRIP ON A RIGID HALF-SPACE WITH A TRANSVERSE PRESSURE: WRINKLING OF NON-BONDED CLADDING. Anderson, W. F. (Liquid Metal Engineering Center, Canoga Park, Calif.). pp C2/6.1-23 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

The problem investigated is that of the stability of a uniform strip resting on a rigid half-space as a base while subjected to both a transverse force pressing it against the base, and an axial force or displacement. The system is shown to be completely imperfection-sensitive, with theoretically infinite buckling loads in the absence of imperfections. The behavior of the strip after buckling ensues is highly nonlinear. The effect of both sharp and smooth (cosine wave) imperfections is studied analytically. A numerical method is also developed for solution of the static buckling problem. Results of the analytical and numerical methods agree. The numerical method is used to obtain the static buckling load where the base has uniformly distributed imperfections of random magnitude. Forty-nine cases of buckling, with the base having random imperfections, are studied and a correlation is shown between the magnitude of the axial buckling force and the RMS value of the magnitude of the random imperfections. 14 references. (auth)

54316 THERMAL STRESSES IN CLAD, PELLET STACKS, AND THE PROBLEM OF INTERFACE STRESS STATES. Carey, J. J.; Valentin, R. A. (Argonne National Lab., Ill.). pp C3/2. 1-16 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

An analytical solution is presented for the elastic interaction of fuel pellets and cladding in the limiting case of zero interface shear. In particular, expressions are developed for the contact stress between cladding and fuel in the neighborhood of a pellet-to-pellet interface. The formulation assumes a pellet description which is exact within the classical theory of elasticity while the cladding is approximated by a simple shell theory. Extensive numerical results give interface pressure distributions for various ratios of the occurring elastic and geometric parameters. Of interest are the areas of reduced local pressure slightly away from the pellet edge due to the "bridging" effect of the cladding caused by the local high curvature of the pellet. Deformed shapes of the fuel element are given for various strengths of cladding ranging from very soft to infinitely rigid. Included is the stress concentration factor applicable to the plane strain value of the interface pressure to give the true localized maximum normal stress. 4 references. (auth)

54317 MECHANICAL FUEL-CAN INTERACTION EFFECTS ON FUEL ELEMENT THERMAL FREQUENCY RESPONSE. Thompson, J. J. (Univ. of New South Wales, Kensington, Australia). pp C3/3.1-13 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

A linear thermoelastic model has been used in a study of the effect of including the contact pressure dependence of the fuel can contact conductance in the equations describing both the symmetric thermal frequency response to power and coolant or heat transfer fluctuations and the asymmetric static problem of slightly tilted power and coolant temperature distributions. In the latter, analytical solution was feasible and formulae for the can surface heat flux are given. The former was reduced to coupled equations by Galerkin's method and solved by a general linear analysis computer code. A specific example is discussed. In both cases the inclusion of the pressure dependent conductance was most significant for internal power rather than coolant temperature changes, and was influenced by the temperature dependent fuel conductivity. Errors of the order of 10% due to neglecting this effect were obtained for the example chosen. The Galerkin method, using a third order polynomial for can temperature, and a sixth order even polynomial for the fuel was found to be adequate over a frequency range from 10^{-3} to 10^{2} radians per second. (auth)

54318 THERMAL STRESSES IN CLAD FUEL ELEMENTS PART. I. CYLINDRICAL FUEL ELEMENTS PART. II. SPHERICAL FUEL ELEMENTS. Smith, C. O. (Univ. of Detroit). pp C3/6.1-25 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp). Luxemburg; Commission of the European Communities (1971).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Equations for the thermal stresses developed in internally and externally clad cylindrical elements with radially symmetric temperature distribution are presented. For illustration, temperature and thermal stress distributions for four fuel element configurations (three cylindrical and one flat plate) with uniform heat generation in the fuel and no heat generation in the cladding are pictured and compared. Some conclusions of practical significance are drawn from this comparison. Equations are presented for the thermal stresses developed in externally clad hollow spheres with radially symmetric temperature distribution. The cases of clad solid and hollow spherical fuel elements, having uniform heat generation in the fuel and no heat generation in the cladding, are used for illustration. The temperature and thermal stresses developed in the clad hollow element are calculated on deterministic and probabilistic bases (taking into account the range of all variables concerned). A comparison of the two sets of values is made with particular reference to reliability in design. 11 references. (auth)

54319 TREATMENT OF MECHANICAL AND THERMAL BEHAVIOR OF FUEL PINS IN SATURN 1. Depisch, F. (AEG-Telefunken, Grosswelzheim, Ger.); Elbel, H.; Kaempf, H. pp C4/2.1-15 of Structural Mechanics in Reactor Technology. Vol. 1, Pt. C. /Jaeger, Thomas A. (comp.). Luxemburg; Commission of the European Communities (1971). (In German).

From 1st International conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

In SATURN 1 the time history of a fuel pin concerning the radial distributions of temperature, stress, porosity and geometry changes is calculated. The operating fuel pin conditions such as linear rod power, outside temperature of the cladding and outside pressure are time dependent input data, so steady state and cyclic conditions are taken into account. The following material phenomena essential for the mechanical and thermal behavior are interconnected in SATURN 1: creep of fuel and clad, swelling of fuel and clad, thermal expansion, crack formation, fission gas release, porosity migration, and heat transfer fuel-clad. Three thermal-mechanical states are distinguished: fuel and clad in mechanical interaction, freestanding fuel and clad stressed by gas and coolant pressure, and freestanding stressed clad in contact or not in contact with cracked fuel assumed to be free of stresses. Three fuel zones are distinguished especially with view to different creep and porosity migration behavior. To demonstrate the possibilities of SATURN 1 several illustrative applications are given. 6 references. (auth)

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GENERAL

54320 (A/CONF.49/P–108) CONTRIBUTION OF THE NUCLEAR RESEARCH CENTRE INSTALLATION TO THE TECHNOLOGICAL DEVELOPMENT OF URUGUAY. Spitalnik, J. (Nuclear Research Centre Project, Montevideo, Uruguay). Jun 1971. 16p. (CONF-710901–468). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

54321 (A/CONF.49/P–200) SIGNIFICANCE OF NUCLEAR SCIENCE AND TECHNOLOGY FOR EDUCATIONAL INSTITUTIONS IN A DEVELOPING COUNTRY. Moreira Bandeira de Mello, Wilson (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro). Jun 1971. 20p. (CONF-710901–353). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

IAEA Member States were grouped in four categories representing states of nuclear technology development. The methods used within these groups for educating and developing manpower for the production and use of nuclear energy were then analyzed. The analysis resulted in suggestions whereby educational and financial resources might best be used in allowing a member of one group to move into a group more advanced in the nuclear field. (D.E.B.)

54322 (A/CONF.49/P–206) INTERNATIONAL NUCLEAR INFORMATION SYSTEM. AN EXERCISE IN INTERNATIONAL CO-OPERATION AND A SERVICE TO NUCLEAR SCIENTISTS AND ENGINEERS. Pelzer, Charles W.; Turkov, Zhan; Woolston, John E. (International Atomic Energy Agency, Vienna (Austria)). Jul 1971. 14p. (CONF-710901–437). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The International Nuclear Information System (INIS) describes and indexes information published in 36 countries and by 8 international organizations. The descriptions are distributed on computer magnetic tape, in an announcement bulletin and on microfiches. Users of the system can select information on specific subjects from the total file. Thus individual scientists and engineers can be provided with both recent and retrospective information from world-wide sources. The unique and distinctive feature of INIS is its decentralized operation, an approach never attempted before on an international scale. Input to the system is provided by the country or organization in which the information is first published, so the amount of work required of each participant is normally proportional to the scale of its nuclear program. Input is received by the IAEA in Vienna, where it is checked and processed by a computer and by documentalists and output files are distributed for exploitation in participating countries. Also, the IAEA provides the forum in which the participants meet to give overall direction to INIS and to define the modalities of its future development and organizes seminars and other mechanisms of training for the personnel providing input to INIS and exploiting its output. The INIS system design was prepared by an international group of consultants and approved at meetings of experts from the participating countries. The major part of the cost is carried by the various countries and organizations in financing their own participation. The central cost, partly offset by sales of output products, is borne on the regular budget of the IAEA. Participating countries, particularly developing countries without computer-based information-processing capabilities, are encouraged to combine to form centers either for INIS activities alone or for INIS activities in association with information services covering other fields of science and technology. (auth)

54323 (A/CONF.49/P–266) NATIONAL NETWORK OF INIS IN JAPAN. Nagayama, T.; Shichi, D. (Japan Atomic Energy Research Inst., Tokyo). May 1971. 15p. (CONF-710901–101). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

54324 (A/CONF.49/P–341) STATE COMMITTEE FOR NUCLEAR ENERGY OF THE SOCIALIST REPUBLIC OF ROMANIA AND ITS ACTIVITIES IN THE FIELD OF INTERNATIONAL CO-OPERATION. Georgescu, A.; Rodean, E.; Manzatu, I.; Ionescu, V.; (and others) (State Committee for Nuclear Energy, Romania). Jun 1971. 18p. (CONF-710901–374). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The organization of the State Committee for Nuclear Energy and its main tasks in achieving the national nuclear program in Romania are described. Taking into account the catalytic role the development of international cooperation plays within the present technical and scientific revolution, some problems connected to its importance for the field of nuclear development in Romania are approached. Romania's experience in the international cooperation, in the peaceful uses of the atomic energy, emphasizing the role of bilateral and multilateral international cooperation is reviewed. The significance of the Articles IV and V of the Treaty on the Non-Proliferation of Nuclear Weapons, which stresses the necessity of international cooperation with the purpose of development, as a legal obligation of the states is emphasized. (auth)

54325 (A/CONF.49/P–420) WORLD ENERGY REQUIREMENTS AND RESOURCES IN THE YEAR 2000. (United Nations, New York. Dept. of Economic and Social Affairs). Jul 1971. 21p. (CONF-710901–439). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Existing long-term projections of energy demand at global and regional levels (for example, developed private enterprise economies, centrally planned economies and developing countries) are reviewed. Long-term factors influencing the demand for energy in countries in various stages of socio-economic development are assessed. Likely shifts in the demand for energy over the long-term period in the light of various assumptions relating, among others (a) to prospective economic growth rates and (b) to technological changes and innovations that may produce major shifts in the long-term pattern of energy consumption are identified. Special attention is paid to the changes in the sectoral composition of output and identify the prospective evolution of energy demand by major consuming sectors (industry, agriculture, transportation). Factors taken into account include the prospective growth rates of population, technical progress, industrialization, urbanization, mechanization of agriculture, electrification, and environmental considerations. Available information on estimates of reserves of conventional sources of energy (fossil fuels, etc.) is brought together and literature relating to prospective exploration activities which may result in the addition to such reserves is examined. Forecasts of technological changes in the energy field affecting the availability of energy supplies with particular accent on new sources of energy are reviewed. 17 references. (auth)

54326 (A/CONF.49/P–421) SCIENCE AND TECHNOLOGY STRATEGY OF THE UNITED NATIONS; THE ROLE OF NUCLEAR TECHNOLOGY. Chatel, B. (United Nations, New York. Office for Science and Technology). Jun 1971. 18p. (CONF-710901–375). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The main elements of the overall strategy of the United Nations are reviewed briefly and the place occupied by nuclear technology within these international plans is discussed. (D.H.M.)

54327 (A/CONF.49/P–511) INTERNATIONAL CO-OPERATION IN NUCLEAR PROJECTS AND EXCHANGE OF INFORMATION. Peirson, D. E. H. (United Kingdom Atomic Energy Authority, London (England)). May 1971. 7p. (CONF-710901–228). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

54328 (A/CONF.49/P–516) PEACEFUL USES OF NUCLEAR ENERGY AND PROSPECTS OF NUCLEAR POWER IN IRAN. Afshar-Bakeshloo, A.; Farivar Sadri, N.; Panahandeh, H.; Parnianpour, H.; (and others) (Tehran Univ. (Iran). Nuclear Center). Jun 1971. 26p. (CONF-710901–393). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

54329 (A/CONF.49/P–568) POST-GRADUATE STUDIES AND PROFESSIONAL TRAINING WITHIN THE SPHERE OF THE ARGENTINE NATIONAL ATOMIC ENERGY COMMISSION AN EXPERIENCE IN LATIN AMERICAN COOPERATION. Libanati, Nelly Ambrosis de; Baro, Gregorio B. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). Jun 1971. 20p. (CONF-710901–396). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The diffusion of new nuclear sciences and techniques in university programs, research centers, and industries is analyzed.

The evaluation of results arising from the postgraduate training program developed in the last 15 years by the Atomic Energy Commission of the Argentine Republic makes evident the importance of this work for such expansion. The communication and collaboration among Latin American countries are shown through the programming of Panamerican activities in the areas of nuclear medicine, metallurgy, radioisotopes applied to industry, nuclear reactors. The possibilities of optimizing postgraduate teaching of nuclear science and technology are studied in order to get them soon introduced in the productive life of the country. (auth)

54330 (A/CONF.49/P–638) ORGANIZATION OF RESEARCH IN THE GRENOBLE NUCLEAR CENTRE IN CONJUNCTION WITH THE UNIVERSITY AND INDUSTRY. Balligand, P.; Mitault, M. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr 1971. 12p. (In French). (CONF-710901–303). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

One of the purposes of the C. E. A. when founding the CEN-G was to develop close connections with the University and Industry. The various laboratories of the CEN-G have come to play an important role as a relay between the University and Industry. The research teams of the CEN-G laboratories include an important proportion of University scientists among whom several professors play the part of scientific advisers. There are more than 150 contracts with public or private organisms. New structures have been and are being created to obtain a more efficient collaboration: the creation of the LETI, the presence in the CEN-G of teams or laboratories from industry. The following fields are principally concerned: desalination, new materials for electronics and metallurgy, low temperatures, irradiation devices. On the international level, the CEN-G welcomes every year about one hundred foreigners from every country, animates study groups, notably in Brazil and Peru and accomplishes missions of scientific cooperation for the IAEA, particularly in Morocco. (auth)

54331 (A/CONF.49/P–683) ACTIVITIES OF THE COUNCIL FOR MUTUAL ECONOMIC ASSISTANCE IN THE PEACEFUL USES OF ATOMIC ENERGY. May 1971. 21p. (CONF-710901–320). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The main principles, experience, organization, and results of the CMEA countries' multilateral collaboration in the peaceful uses of atomic energy are outlined. The initial period of this collaborative work when atomic science and technology were developed and nuclear research centers were organized in socialist countries with Soviet technical assistance is described. In 1960 the growing complexity of problems associated with economic applications of atomic energy led to the formation of the CMEA Standing Commission on Peaceful Uses of Atomic Energy. This Commission organizes multilateral collaboration in the peaceful uses of atomic energy. The main questions, forms, and methods of intra-CMEA collaboration in the major fields of the peaceful uses of atomic energy (atomic power generation, nuclear instruments, isotope production and applications, radiation security and shielding) are considered. The major aspects and forms of intra-CMEA work on the peaceful uses of atomic energy in the current period are considered. This work will promote the implementation of the decisions, taken by the 23rd and 24th CMEA Sessions in 1969–1970, as regards the development of the member countries' collaborative activities and their socialist economic integration. (auth)

54332 (A/CONF.49/P–724) SYNOPSIS OF THE ACTIVITIES OF THE JOINT RESEARCH CENTRE OF THE COMMISSION OF THE EUROPEAN COMMUNITIES. Caprioglio, P.; Schleicher, H. W. (European Atomic Energy Community, Ispra (Italy). [Joint Nuclear Research Center]). May 1971. 14p. (CONF-710901–322). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The research activities at the present time carried out by the Commission of the European Communities comprise research work executed at the JRC and studies made under research contracts signed with public institutions or private organizations or under association agreements between laboratories. These contracts refer in particular to reactor development as well as to biology-health protection, thermonuclear fusion and plasma physics. The activities of the Ispra establishment in the field of nuclear reactors are mainly related to research on materials, reactor physics and safety problems. Concerning materials, particular attention is paid to those exhibiting good resistance to high temperatures and stresses; in reactor physics, among other activities, two and three dimensional codes for fuel management and reactor dynamics have been developed. The safety studies deal in particular with cooling accidents (e.g., interaction between coolant and molten fuel), the behavior of materials and structures under explosive transients, and with problems of reliability. The ESSOR test reactor which was initially built to carry out experiments on organic-cooled fuel elements may be used, after insertion of water-loops, to study fuel elements for the European industries. The activities in fundamental research are mainly in solid state physics and in particular crystallographic studies and neutron optics. A pulsed fast reactor project (SORA) is now in the final design stage and is being considered for construction. This reactor will be a most efficient neutron source for research in solid state and neutron physics. In biology and health protection, studies on irradiation effects related to the risks for living organisms are underway at Ispra. Applications of nuclear techniques in agronomic and medical research are executed under contract with national institutions. The activities of the Petten establishment are focused on problems emerging from the preparation and the development of pyrocarbons, as well as on the properties of graphite and refractory compounds under irradiation. These studies are related to the development of high temperature gas cooled reactors. The HFR-reactor at Petten, whose power was increased recently from 20 to 45 MW, is an important tool for these experiments. The studies carried out at the European Transuranium Institute (Karlsruhe) on the fuel for fast reactors represent a basic program meant to clarify the phenomena which affect fuel materials containing plutonium under irradiation. The activities of sample preparation, chemical and radio-chemical analyses of irradiated fuel require skills and equipment which are frequently used by other laboratories of the Community. The Central Bureau of Nuclear Measurements (Geel) is essentially dealing with high-precision measurements of neutron cross-sections at various energies as well as precision measurements of radioactivity, fissile constants and neutron dosimetry. For these activities and on the request of other institutions samples are prepared and defined. (auth)

54333 (A/CONF.49/P–737) PLACE FOR COOPERATION ON A REGIONAL BASIS. Saeland, Einar (European Nuclear Energy Agency, Paris (France)). May 1971. 14p. (CONF-710901–324). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

Over the past 14 years, European countries of OECD (formerly OEEC) have collaborated through the European Nuclear Energy Agency in joint activities for the development of nuclear energy for peaceful purposes. These activities have included technological and economic studies, the handling and diffusion of nuclear information and data, applications of radioisotopes, and the development of appropriate legal and regulatory measures to ensure the efficient and orderly exploitation of nuclear energy. But most particularly, they have included a number of practical co-operative projects concerned with the development of advanced reactors, with reprocessing technology and with other aspects of the fuel cycle (including radioactive waste management). Thus ENEA has accumulated a wide range of first hand experience of the problems involved in regional co-operation, and of both the scope for and limitations of such co-operation in fields of rapid technical advance and evolving relationships between Governments, governmental institutions and industry. These factors are discussed, with particular reference to their influence on the scope for regional co-operation in the nuclear field between mainly advanced countries in the 1970's. (auth)

54334 (A/CONF.49/P–742) IMPACT OF NUCLEAR TECHNOLOGY IN DEVELOPING COUNTRIES. Sarabhai, Vikram A. (Atomic Energy Commission, Bombay (India)); Thomas, K. T.; Meckoni, V. N. (Bhabha Atomic Research Centre, Bombay (India)); Parikh, Kirit S. (Department of Atomic Energy, Bombay (India)). Jun 1971. 30p. (CONF-710901–423). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

The manner in which nuclear technology has been accepted and developed in India for providing to the country a powerful impetus for development is described. New organizational structures, administrative practices, and operating culture have evolved within the framework of traditional Government and Society for meeting the special needs of innovation in applying the peaceful uses of atomic energy. Direct benefits through providing nuclear energy economically in areas where other alternatives are less advantageous, viewing the long term needs of energy for the development of the nation and parallel applications of radiation and isotopes in diverse fields are evaluated. Examples are cited of the widespread implications to and involvement of diverse agencies and segments of national life, in the peaceful uses of atomic energy in India.

The spin off from specialized personnel training and practices as well as technology in the nuclear field to others such as desalination of water, electronics, metallurgy and, above all, application of scientific methods to problems of development are some of the indirect benefits which can permit a developing nation to leap-frog from economic backwardness. The infra-structure that is required for the applications of advanced technology is considered and the impact of national self-confidence and determination to progress is discussed. (auth)

54335 (A/CONF.49/P-743) INTERNATIONAL COOPERATION OF THE USSR IN THE FIELD OF PEACEFUL ATOMIC ENERGY UTILIZATION. Afonin, G. S.; Balasanov, Yu. G.; Morochov, I. D.; Semenov, B. A.; (and others) (State Atomic Energy Committee, USSR). Aug 1971. 28p. (CONF-710901-461). Dep. NTIS (U. S. Sales Only).

Prepared for 4th international conference on the peaceful uses of atomic energy; Geneva, Switzerland (6 Sep 1971).

International cooperation of the USSR in peaceful utilization of atomic energy over the period between the III and IV Geneva conferences is discussed in the paper. The information on the bilateral and multilateral agreements concluded over this period as well as on the development of cooperation on their basis is given. The progress in the field of such traditional forms of international cooperation as exchange of visits of scientists, exchange of scientific and technical information, participation in the work of international meetings, symposia etc. is considered. The information on the USSR assistance in establishing of scientific research centers and in preparation of specialists for meeting the needs of nuclear science and industry of a number of countries is presented. The perspectives of international cooperation in the frame of the IAEA are given and the information on the contribution of soviet scientists in the activity of international organizations is presented. The information on the further development of the forms of international cooperation is reviewed and the examples of organization and implementation of joint research and development projects carried out by soviet and foreign scientific-research centers and specialists are presented. (auth)

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54337 (A/CONF.49/P-801) ANGRA NUCLEAR POWER PLANT (BRAZIL). ITS IMPACT ON THE TECHNOLOGICAL ACTIVITIES IN THE COUNTRY. Lyra, F. H.; Simon, D. N.; Ferreira, H. A. Jr. (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro). Jun 1971. 12p. (CONF-710901-430). Dep. NTIS (U. S. Sales Only).

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The impact of the Angra Nuclear Power Plant on technological activities in Brazil is described. Although Brazil has already acquired considerable experience in hydro-electric power, its experience in thermal power technology still requires further development in design know-how, as well as in general project coordination. The site for the plant location had to be selected by Furnas (the operator of the utility) within its area of responsibility for electrical supply. This selection involved several new and important fields of investigation, including the fields of oceanography, geology, geophysics, meteorology, and radioecology. A specification had to be developed for the NSSS as well as the conventional equipment, covering the several different nuclear reactor types currently being utilized in the world. Several computer programs had to be developed to conduct the financial evaluation of the bids. The regulations in current use by different countries were analyzed and corresponding Brazilian norms were developed. In the absence of any Brazilian codes and standards covering nuclear plant safety, design and construction as well as precautions for fuel force in the country of origin of the equipment supplied, as well as those of the IAEA. The major financial and contractual conditions included in the bidding specifications are discussed. Existing International Agreements to which Brazil is a party concerning fuel supply and related services had to be modified since they were applicable only to research reactors, the general idea being to reach new or modified International Agreements in such a way as to assure Furnas or other operating utilities satisfactory access in the future to fuel supplies and to enrichment and fabrication services within the existing International Agreements. The progress of the negotiations is described in this paper. (auth)

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Germanic	ä appears as	ae
Germanic	ö	oe
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SUBJECT INDEX

Cross references are included in cumulative subject indexes and in *Subject Headings Used by the USAEC Division of Technical Information* (USAEC report TID-5001).

The reader is also referred to *Guide to Abstracting and Indexing for Nuclear Science Abstracts* (USAEC report TID-4576).

Most headings in the subject index are specific materials, things, and processes. The headings are followed by modifiers that describe the properties of, or processes applied to, the headings.

All index entries cite *NSA* volume and abstract numbers; volume number precedes the colon and the abstract number follows it. The designation (R) following the abstract number indicates a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Report numbers, where applicable, are included in parentheses after the abstract number of the citation. Published literature (journal article or book) can be identified by the absence of a report number.

Ideas presented in the original literature, rather than key words, have been indexed. The indexers have selected what seemed the most probable and logical place to look for typical information. Since it is not always possible to anticipate where a user would look for information, the cumulative indexes include numerous cross references. Consideration of synonymous or closely related terms will prove valuable.

Information is indexed for the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use or to the general class headings that include the specific headings. For example, information on boiler design for the Fermi Fast Breeder Reactor would be indexed under the headings BOILERS and FERMI FAST BREEDER REACTOR but not necessarily under the headings REACTORS, FAST or REACTORS, BREEDER.

General or broad headings are reserved for general summaries, reviews, comprehensive reports, and similar literature.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings; e.g., AMINO ACIDS rather than ACIDS, AMINO; HELIUM ISOTOPES He-4 rather than HELIUM—ISOTOPES He-4 or HELIUM—He-4 ISOTOPES. Note, however, that in some cases parenthetic modifying terms or inverted headings such as NEUTRONS, FAST, are used where the alphabetical arrangement of a direct entry would cause information to be scattered. In addition, organic compounds are usually entered in the index in the inverted form to facilitate grouping like or related compounds with the parent compounds; e.g., BENZENE, BROMO- rather than BROMOBENZENE. In general, the nomenclature used is that of the subject indexes to *Chemical Abstracts*.

Alphabetization

Subject headings are alphabetized word by word. Parenthetic qualifiers, numbers, and Greek letters within subject headings are disregarded in alphabetizing unless there are two or more headings that are otherwise identical, in which case the qualifier, numerical progression, or spelled names for the Greek letters determine the order.

Examples:

M-Capture
  see ELECTRON CAPTURE
MAGNESIUM
MAGNESIUM ALLOYS AND SYSTEMS
MANGANESE FLUORIDES
MANGANESE FLUORIDES MnF_2
MESONS
MESONS (π)
MESONS (ρ)
1-PENTANOL
2-PENTANOL

Modifying Phrases

The modifiers appearing under a subject heading are written specifically to show the relation between the item being indexed and the heading. The modifier therefore contains a maximum of useful information. Although the modifier begins with the word judged to be of greatest use to the greatest number of users, there is still need for the searcher to consider all modifiers under the heading(s) of interest.

Modifiers usually form meaningful phrases when combined with the subject heading. Some are intended to be read following the subject heading, e.g., the entry HYDROGEN—sorption by charcoal should be read "hydrogen sorption by charcoal." As a result of placing the important word first, however, many modifiers must be rearranged for smooth reading, e.g., FORMALDEHYDE—yields in radiolysis of ethyl ether, effects of deuterium on, should be read "effects of deuterium on formaldehyde yields in radiolysis of ethyl ether" and URANIUM—crystal structure of, effect of cooling rate on allotropic transformations in, should be read "effect of cooling rate on allotropic transformations in crystal structure of uranium."

Special characters are added to modifiers in the fields of physics and reactor technology; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the abstract number.

XUM

Physical States and Configurations of Materials

The specific physical state, if other than normal, or the geometric configuration of the material is included in the modifying phrase; e.g., information on liquid metals is indexed under the specific metal with "liquid" in the modifier and carbon crucibles is indexed under CARBON with "crucibles" appropriately placed in the modifier. The information on carbon crucibles is also indexed under CRUCIBLES.

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed to subject headings in the direct form. Cations are listed in the order of increasing valence for polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., SODIUM ALUMINUM SILICATES and POTASSIUM SODIUM SULFATES. If more than one anionic species is presented in a compound, the anions are arranged alphabetically, e.g., BERYLLIUM FLUORIDE HYDROXIDES.

Nomenclature of Organic Compounds

Organic compounds are indexed by subject headings based on the indexes to *Chemical Abstracts* except in the area of enzymes, in which specific enzymes, named according to the 1964 recommendations of the International Union of Biochemistry, are used. In many cases nonproprietary names for drugs are used as subject headings, and cross references are made from the systematic chemical names. Subject headings for hormones appear in the inverted style at HORMONES.

Nomenclature of Life Sciences

Subject headings for plants are names of phyla with one exception: members of the Phylum Tracheophyta are indexed under class or subclass names. Scientific names (genus and species) are used as the initial, or file, word in the modifying phrase. Scientific names are omitted only when the name is not available in the literature or cannot be found in available references.

Subject headings for animals are the names of phyla with the following exceptions: (1) members of Phylum Arthropoda and Phylum Chordata are indexed under appropriate class name, and (2) common names are used for members of Class Mammalia.

Subject headings are entered for various classes of commodities, and specific products are identified in the file-word position of the modifier. In the following examples, approved subject headings are capitalized and typical modifier file words are listed in lower case.

Example 1	Example 2
CEREALS	MEATS
bread	beef
flour	fish
oats	mutton
rice	pork
rye	poultry
wheat	seafood

Diseases, pathological conditions, and in vitro studies of atypical cells and tissues are indexed under subject headings for the organism affected, under the appropriate anatomical structure of physiological phenomenon affected, and under the appropriate disease heading. Subject headings for diseases (defined as any deviation from the norm) are DISEASES; DISEASES, INFECTIOUS; DISEASES, NEOPLASTIC; DISEASES, PHYSIOLOGICAL; DISEASES, PLANT; and DISEASES, TRAUMATIC.

Diseases of mixed etiology are treated in the following manner: neoplastic diseases that are also classified as infectious or physiological are indexed under DISEASES, NEOPLASTIC; diseases in which a microorganism is the etiologic agent are classified under DISEASES, INFECTIOUS; physiological anomalies that are neither neoplastic nor infectious are indexed under DISEASES, PHYSIOLOGICAL; the acute radiation syndrome, nonspecific radiation injuries, trauma, and wounds or incisions inflicted mechanically are indexed under DISEASES, TRAUMATIC.

Specific diseases or pathological conditions are named in the file-word position of the modifier, in the author's terminology, and are set off from the remainder of the modifier by commas. Neoplasms are designated as benign or malignant in the file-word position when more specific information is not available.

Multicomponent Alloys and Other Systems

Multicomponent alloys and systems, except well-known trade names, are indexed under a subject heading for each component in the form "element systems" for nonmetals or "element alloys and systems" for metals. The modifier begins with element symbols for each component arranged alphabetically. In addition, if significance is placed on the base metal of the alloy, this is indicated by adding "-base" to the element symbol.

Example: A 1.5C, 12Cr, 0.25V, 0.8Mo, bal Fe alloy is indexed as

```
CARBON SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
CHROMIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V,...
IRON ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
MOLYBDENUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
VANADIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
```

Well-known alloys, such as ZIRCALOY-2, are indexed under the trade name; cross references from each component of the alloy to the trade name appear in cumulative indexes.

Multicomponent systems in which nonmetallic elements are present in large percentage and which are commonly referred to as systems or mixtures are indexed in a manner similar to alloys.

Example: A tungsten–silicon preparation is indexed as

```
TUNGSTEN ALLOYS AND SYSTEMS
  Si--W, ...
SILICON SYSTEMS
  Si--W, ...
```

Multicompound systems and mixtures of inorganic compounds are indexed under the subject heading for each component compound; the modifiers begin with an alphabetical listing of compound formulas.

Example: A lead titanate–lead zirconate mixture is indexed as

LEAD TITANATES
  $PbTiO_3$ --$PbZrO_3$
LEAD ZIRCONATES
  $PbTiO_3$ --$PbZrO_3$

XUM

A mixed system of compounds and elements is indexed by a combined form of the preceding conventions; e.g., a dispersion of copper and alumina would be indexed as

- ALUMINUM OXIDES
  - Al_2O_3--Cu, ...
- COPPER ALLOYS AND SYSTEMS
  - Al_2O_3--Cu, ...

Mixtures of organic compounds are indexed under subject headings for each component of the mixture; the modifiers begin with an alphabetical listing of compound names.

Example:

- ACETIC ACID
  - acetic acid--BF_3, ...
- BORON FLUORIDES
  - acetic acid--BF_3, ...

Example:

- BENZENE, CHLORO-
  - bromophenol--chlorobenzene, ...
- PHENOL, BROMO-
  - bromophenol--chlorobenzene, ...

If modifiers for alloys and systems are included with other modifiers under the same subject heading, they are filed last.

Example:

- CARBON SYSTEMS
  - deposition on nuclear fuel particles
  - molecular structure of
  - neutron total cross section for
  - sorptive properties for xenon
  - Young's modulus for
  - Al--C--Cr, superconductivity in
  - B--C, phase studies for
  - C--U--Zr, fabrication and physical properties of

Nomenclature of High Energy Physics

Information on particle-particle events is indexed under subject headings for the specific particles involved. The modifier file word *interactions* is followed by the specific interaction written in symbolic form. Particle nomenclature and symbols follow that of Rosenfeld, et al. *Data on Particles and Resonant States,* UCRL-8030 (latest revision). For consistency the incident particle is always written first. The mass (in MeV) of a resonance state is included in parentheses after the symbol to avoid ambiguity. Hyperfragments are indicated in modifiers as in the following examples: Λ-He^5, Σ-H^3, $\Lambda\Lambda$-Be^{10}. The superscript on the right indicates the total number of baryons in the composite system.

Examples:

- MESONS (π^-)
  - interactions $\pi^- + p \rightarrow \Lambda + K^+ + \pi^-$ at 6 GeV/c in hydrogen bubble chamber, $\Lambda K(1700)$ enhancement in, (E)
- BARYONS, RESONANCE (N*)
  - production of $\Delta^{++}(1236)$ and $\Delta^0(1236)$ from $K^- + p \rightarrow K^- + p + \pi^+ + \pi^-$ interactions at 2.63 and 2.70 GeV/c, (E)
- HYPERFRAGMENTS
  - binding energy of $\Lambda\Lambda$-He^6, three-body α--Λ--Λ model for

Subject headings are also provided for specific models and theories.

Examples:

- ELEMENTARY PARTICLE MODELS (TRIPLET)
  - hadron total cross sections in quark, numerical analysis of
- CURRENT ALGEBRA
  - PCAC hypothesis for A_1 and rho dominance in $\pi \rightarrow e + \nu + \gamma$ decay
- REGGE POLE THEORY
  - predictions for polarization in $K^- + p \rightarrow$ anti $K^0 + n$, $\pi^- + p \rightarrow \pi^0 + n$, and $\pi^- + p \rightarrow$ eta + n interactions at high energies
- SYMMETRY GROUPS
  - $SU(2) \times SU(4)$ intermediate-coupling model for nucleon and hyperon isobars

Nomenclature of Reactor Technology

Subject headings for reactors are of three types:

(1) Specific reactors, e.g., ARGONNE RESEARCH REACTOR, SAXTON POWER REACTOR

(2) Reactors having a common physics or engineering characteristic, e.g., REACTORS, FAST; REACTORS, ORGANIC-COOLED; REACTORS, PRESSURIZED-WATER

(3) Reactors having a common purpose, e.g., REACTORS, POWER; REACTORS, RESEARCH

Information on specific reactors, type (1), is indexed under the one specific subject heading. Information on classes or types of reactors, types (2) (characteristics) and (3) (purpose), is indexed under all applicable headings. For example, information on a heavy-water-moderated organic-cooled power reactor is indexed under REACTORS, HEAVY WATER-MODERATED; REACTORS, ORGANIC-COOLED; and REACTORS, POWER.

Subject headings exist for selected reactor components, e.g., REACTOR FUEL ELEMENTS. When applicable, headings for components are indexed even though they may have been included in a modifier under a type (1) or (2) heading. The materials in reactor components are indexed when the information is peculiar to the material.

Modifier file words under reactor headings are of two primary types: one type expresses reactor characteristics, e.g., reactivity; the other, components, e.g., control rod. If no subject heading appears for a reactor component, the heading REACTORS is used, and the component is used as the modifier file word.

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(Pt.2)	25-51939	Pittsburgh; Instrument Society of America (1969). 223p
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	25-53039	Syracuse, N. Y.; Syracuse University (1969). 329p
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27	25-52068	See COO-1500-18
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CONF-700564-		(10th Annual International Conference of the Canadian Nuclear Association, Toronto, Canada, May 24-27, 1970)
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CONF-700645-		(Conference on Newer Techniques and Technology in Radiotherapy and Oncology, Los Angeles, Calif., June 5-6, 1970)
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CONF-700655-		(Meeting Held at the Radiobiological Institute TNO, Rijswijk, The Netherlands, June 22-24, 1970)
	25-52158	Eur. J. Cancer; 7: No. 2-3, 97-267(May 1971)
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2	25-53281	See IC-71/75
CONF-700811-		(3rd International Symposium on Polarization Phenomena in Nuclear Reactions, Madison, Wis., Aug. 31-Sept. 4, 1970)
	25-53788	Madison, Wis.; University of Wisconsin Press (1971). 956p. $15.00
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	25-52205	Transplant. Proc.; 3: No. 1, 1-978(Mar 1971)
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CONF-700970-		(Symposium on the Applications of Transport Theory, Oxford, England, Sept. 1-4, 1970)
1	25-54119	See RT/ING-(71)2
CONF-701002-		(Symposium on Neutron Standards and Flux Normalization, Argonne, Ill., Oct. 21-23, 1970)
	25-53485	Dep. NTIS, 525p.
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	25-52987	See LA-4637
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	25-51770	See STI/PUB-285
CONF-710316-		(Workshop on Particle Physics at Intermediate Energies, Pasadena, Calif., Mar. 29-30, 1971)
	25-53038	See UCRL-20655
CONF-710319-		(Conference of the American Society of Nondestructive Testing, Los Angeles, Calif., Mar. 8-12, 1971)
1	25-51734	See Y-DL-140
CONF-710328-		(Solar Wind Conference, Pacific Grove, Calif., Mar. 22-26, 1971)
1	25-52555	See LA-DC-12515

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CONF-710618-	(13th Euratom Hot Laboratory Meeting, Juelich, Germany, June 24-25, 1971)	
1	25-51360	See CEA-CONF-1783
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CONF-710623-	(2nd Conference on the Recent Developments in Neutron Activation Analysis, Cambridge, England, June 28-July 1, 1971)	
1	25-51407	Dep. NTIS (U. S. Sales Only), 10p.
CONF-710624-	(International Working Session on Fusion Reactor Technology Conference, Oak Ridge, Tenn., June 28-July 2, 1971)	
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CONF-710710-	(16th Annual Health Physics Society Meeting, New York, N.Y., July 12-16, 1971)	
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3	25-52319	Dep. NTIS, 5p.
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